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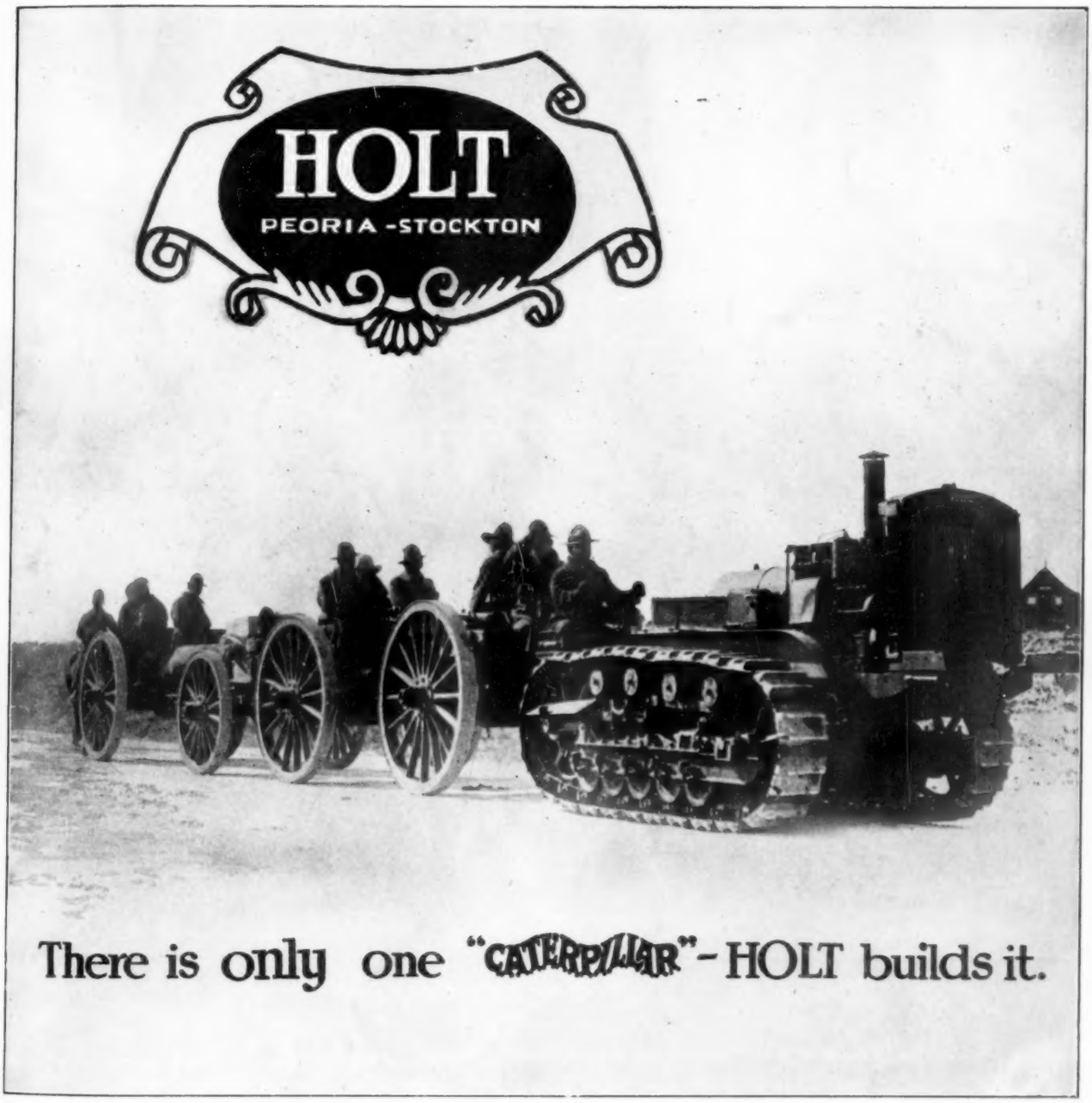

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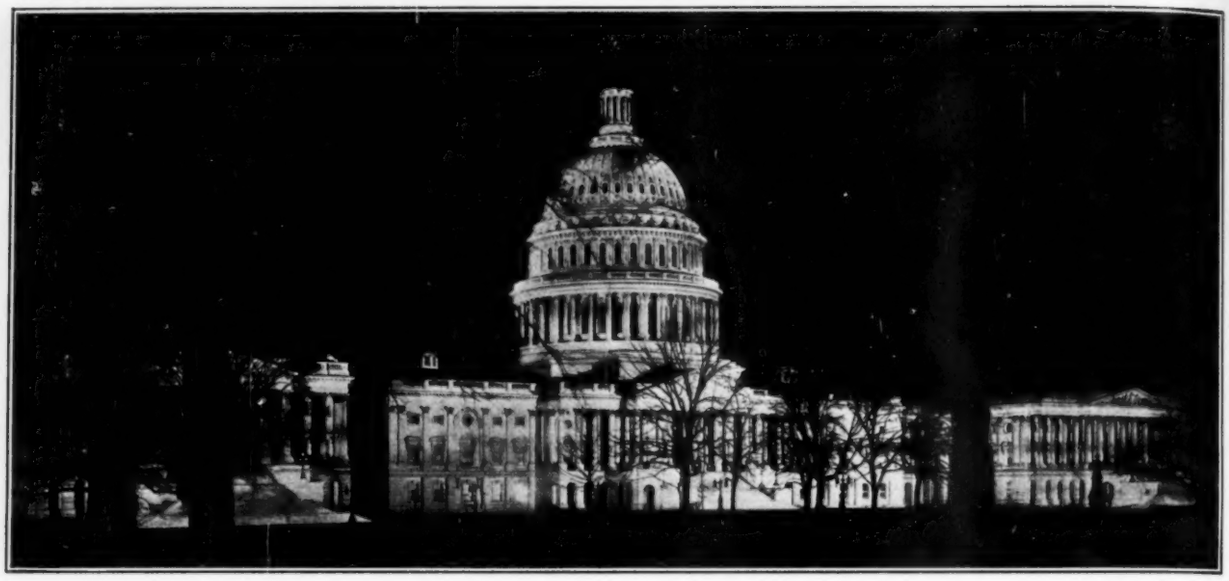


Lest We Forget—

By M. B. MORRIS

The second anniversary of Armistice Day has come and gone.

What was there about this day of celebration of the second year of peace that gave one pause? Is it that the spirit of the first day of Peace has also gone? Is it to return more faintly with each succeeding year, and pass from our minds more completely?

That first Armistice Day, and its essential spirit, are worth remembering. Those who were in Washington must recall the thrill of the tremendous announcement

"GERMANY SURRENDERS"

screamed in big black type from bulletin-boards all over town. Shrill-voiced newsboys were shrieking up and down the Avenue, "Uxtra papur! Uxtra pa-pur! Germa.. surren-durs!"

Waves of excitement were sweeping over the city. Groups of people gathered in gesticulating knots before bulletin-boards; pedestrians paused in the most hazardous positions, holding up traffic, while they scanned the glaring headlines, striving to grasp the truth of the stupendous report.

The excitement gathered force, gained momentum. Automobile loads of people began to honk madly up and down Pennsylvania Avenue, stray patriots suddenly sprouted flags, and telephone bells all over the city were ringing wildly. Washington went suddenly and completely mad. Staid, executive, congressional, residential Washington, which hadn't been itself since the declaration of war, went clear off its head. It paraded, it tooted horns, it waved flags, it blew whistles, it yelled itself hoarse.

Crowds of people, cheering, whooping, laughing, shouting, swarmed its streets. A vast tidal wave of humanity rolled up the Avenue from the Capitol, breaking at the Treasury and dashing in surging sprays against the White House.

And they sang—by the thousands. Clumped like ants about the grim old Treasury, they sang "We Won't Come Back 'Til it's Over Over There," and "When You Come Back, If You Do Come Back," and finally the soaring refrain, "Oh, Say Can You See"—and while the starry words rang in the clear, quivering November air, men stood with their heads uncovered and women with tears streaming down their faces.

On that Armistice Day, whenever the people of the United States looked at their returned soldiers with their overseas caps tilted at rakish angles over eyes that had seen the horrors of the world let loose, they looked respectfully, with something softened, speculative and abashed in their faces. These men had given of themselves to save that for which the world was fighting. When they saw the wounded soldiers tears came into their eyes; hard-bitten men, tough young street gamins, prosperous, sleekly-tailored, dollar-a-year War Workers gave way for them. In the minds of ninety-nine out of every hundred spectators was the thought that these were the lucky ones—theirs had been the privilege of giving.

On this Armistice Day we were bidden to turn our eyes toward the hallowed soil of France where lie the bodies of America's dead; to remember our obligation to those who sacrificed their lives that we might be living peacefully today. There are eyes which need not be turned toward France to fill with tears; and hearts which need no reminder to bleed for their victorious dead. But there is a more vital need than any injunction to remember the sacrifice itself, great and glorious though it was. That is the need for keeping alive the spirit which made that sacrifice possible. More tragic than any human death would be the death of that spirit in man which was so manifest during that time of national stress, the spirit which sank personal profit in regard for the common weal, that quickening of a perception of larger things which differentiates man from the beasts of the fields.

The keeping alive of this spirit is no mere looking back, no dropping of a futile tear, but a keen resolve to keep the "Sword of Peace" shining in its scabbard, to profit by those lessons learned at such bitter cost, to stop RIGHT NOW and ask:

What has the World War taught YOU?

What has the World War taught US as a Nation?

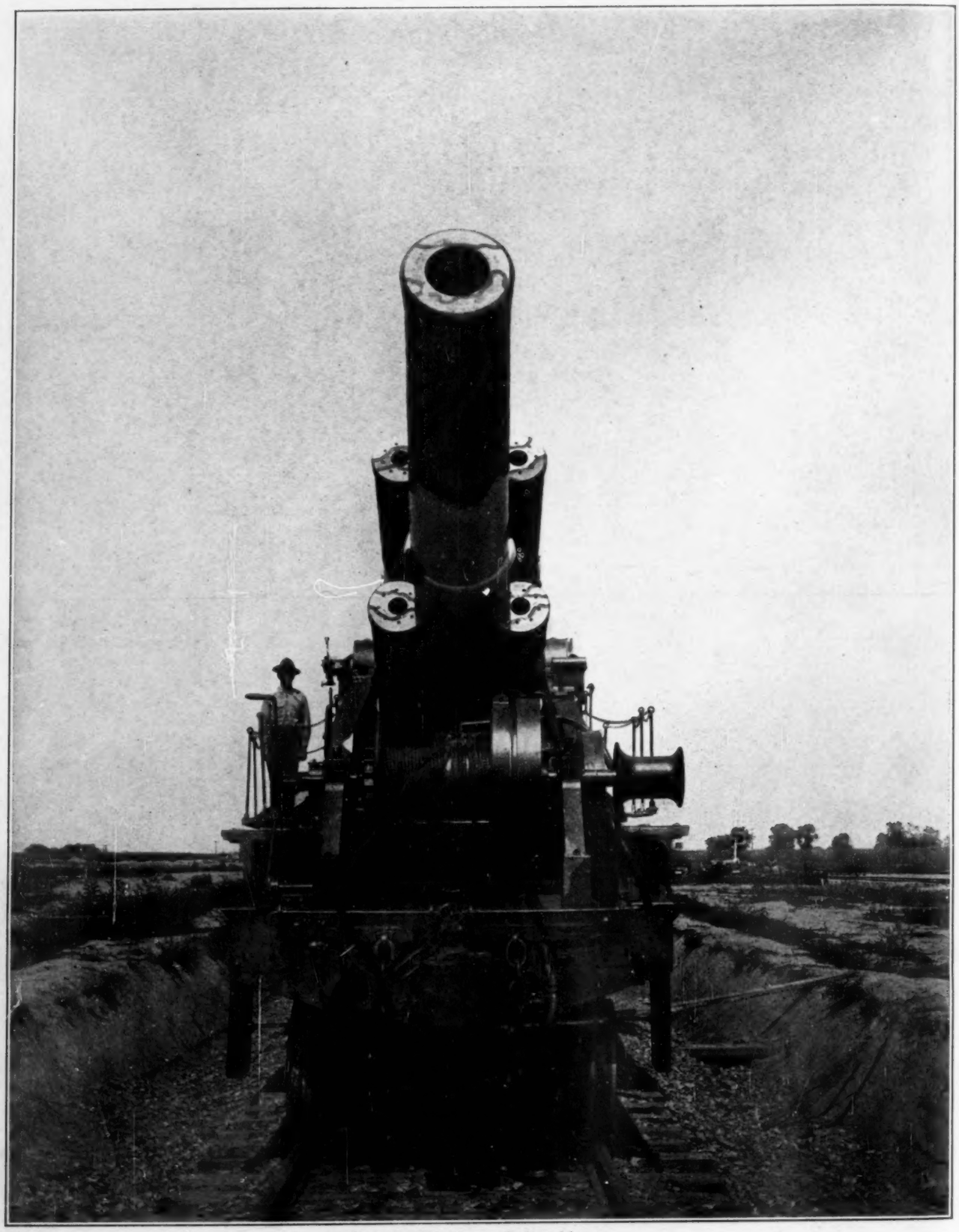
Unless we gain in foresight from lessons learned, unless we build on past experience, we are basing our blind hopes of immunity from disaster on a theorist's dream that the millenium is upon us and the Lion and the Lamb will henceforth lie cozily down together after a fashion entirely foreign to every known precedent.

WE MUST NOT forget those days when the soul of a nation was laid bare.

WE MUST NOT allow the sloth of these times of peace to overtake us again.

WE MUST NOT be allowed to forget the lessons learned through blood and tears.

Remembering the Capitol building that Armistice Night, blazing like a diamond in its setting of white lights, its tiered dome rising with an effect of lofty lightness against the sky, the typified ideal of this country in its fresh beginnings, IT MUST BE that when the pendulum has completed its swing, when the reaction from the war is over, the spirit born during those months of travail will be found to be with us yet.



Sixteen-inch Howitzer on Railway Mount

Railway Artillery

Part II

By

G. M. BARNES

Member A. O. A.

[For the past five years, Colonel Barnes, the author of the following article, has been in direct charge of all matters relating to the design and manufacture of Railway Artillery in the Office of the Chief of Ordnance. He is, therefore, particularly well qualified to discuss the future possibilities of this type of ordnance from the viewpoint of the manufacturer.

It should be borne in mind that the time required to produce a complete unit of railway artillery is determined by the length of time required for the manufacture of the gun proper and its breech mechanism, and the recuperator for controlling its recoil when fired. If these have already been completed, the girder construction and special trucks on which they rest can, on account of their similarity to commercial bridge girders and standard railway trucks, be finished in a few months as was done so spectacularly during the World War.—ED.]

THE railway gun-carriage was developed almost entirely during the World War. A few mounts had been built previously, some as far back as the American Civil War, but never before had guns 12 to 15 inches and howitzers 16 to 21 inches in caliber been placed upon mobile carriages and used to accompany armies in the field. The World War early developed into a conflict of fixed positions, and the lines between the Germans and the Allies soon became practically stationary. Each side desired to reach further and further to the rear of the opposing lines in order to strike vital points. This called for the use of major caliber guns. Consequently, guns mounted on railway carriages gradually began to appear on both sides until finally each country engaged was fully equipped with a large assortment of mounts, most of which were improvised from existing materiel.

Railway artillery was used principally for destroying cities, ammunition dumps, concentration camps, storage depots, railway terminals and bridges. It had a very important effect upon enemy morale, for in case an army retreated at any point, the opposing railway artillery could be pushed forward to cover some more important city or camp formerly out of range. The smaller calibers were also used for interdiction fire upon roads, lines of communication, etc., and to some extent for destroying enemy batteries, which were so distant or so well protected as to be beyond the destructive power of the Army artillery.

Fig. 1. 10-inch Sliding Railway Mount. Range, 27,000 yards

The sliding or *glissement* railway mount is an excellent example of the railway artillery extensively used in France for carrying out this long range fire of destruction. The carriage was developed by the French early in the War and was more extensively used than any other, due to its simplicity. The most remarkable thing about it is, that it has no recoil mechanism or recuperator system. The carriage is built of sufficient strength to withstand the shock of discharge of the gun. When the gun is fired, the unit slides back about three feet along the track. The sliding carriage shown in Fig. 1 (10-inch sliding railway mount), was manufactured at Watertown Arsenal. It mounts the 10-inch Army gun.

The gun is laid in direction by moving the mount along a specially constructed curved track called an epi. (See Fig. 2.) This consists of a rock ballasted road bed with special ties and track laid with a radius of approximately 500 feet. Four lines of 10-inch I-beams are spiked to the ties parallel to the standard gauge rails. In moving the mount about 88 feet from one end of the epi to the other, a change of direction of five and one-half degrees is obtained, which is sufficient for the adjustment of fire. Six cross-sleepers attached to the mount are let down, by means of screw jacks built into the girders, so as to bear hard against these I-beams. The energy of recoil of the gun is dissipated in moving the mount against the friction of these cross-sleepers upon the I-beams and in deforming the road bed. The range with a 617-pound projectile is 27,000 yards. This type is well suited for land warfare. It permits large guns and howitzers to be quickly brought to the point where most needed. It permits them to be fired at fixed targets and withdrawn before the enemy can accomplish their destruction. This carriage, like many others built during the war period, demonstrates the value of railway artillery for land defense.

The trend of development in artillery is always towards increased ranges. The artillery of yesterday is outranged by the artillery of today. The new Divisional, Corps and Army weapons, which are now under development, have a much greater range than those which they are to replace. In the endeavor to obtain longer ranges, the larger field weapons have already outgrown wheel carriages and are now being mounted upon caterpillar mounts, which allow the use of heavier guns and howitzers.

The railway carriage, which mounts still heavier guns and howitzers, is, therefore, a natural development to meet this condition, and it is safe to predict that in the next war between two or more first class powers, railway artillery will be even more extensively used than it was during the World War.

Use of Railway Artillery for Seacoast Defense

Since the armistice there has been a rather lively discussion among officers in the various branches of the service concerning the use of the railway carriage for seacoast defense. Some officers are much in favor of the new weapon, while a few are opposed to its adoption.

Those in favor of railway artillery point to its mobility. They state that a railway mount can be moved from place to place and made to fulfill the functions of several. Thus one inadequately defended point can be reinforced by the concentration of all the railway artillery in the vicinity

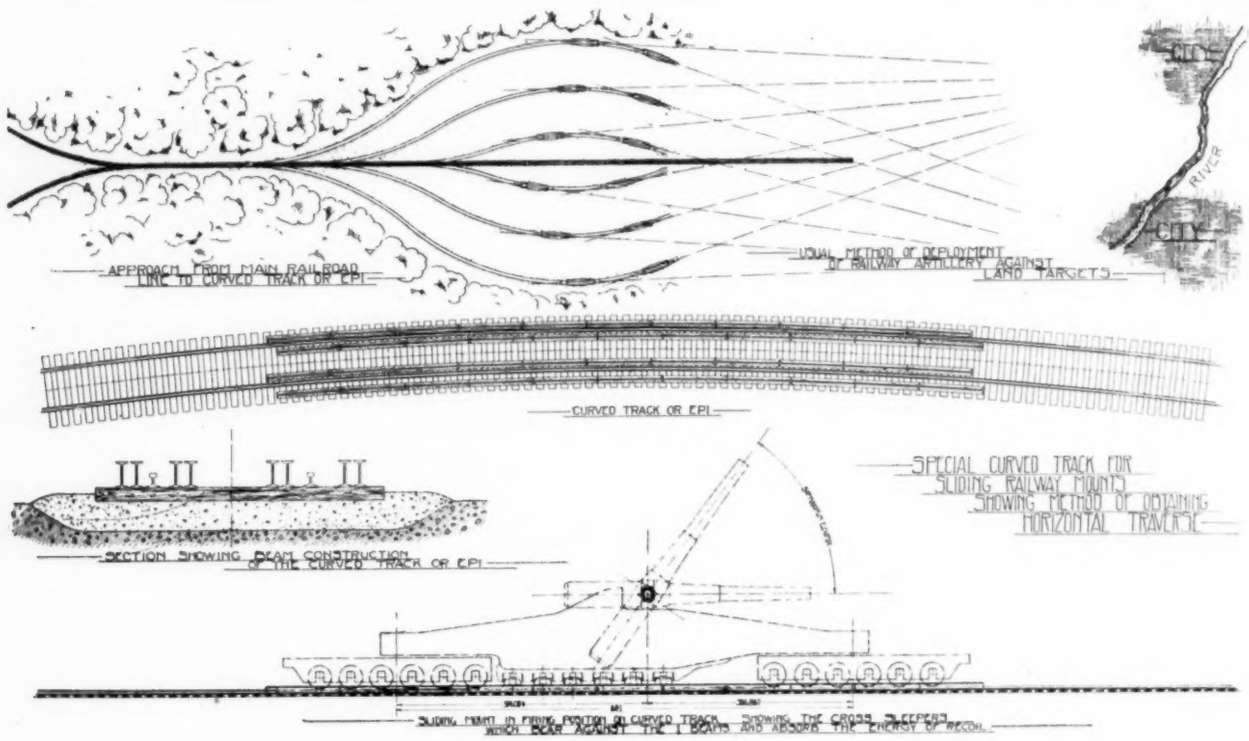

APPROACH FROM MAIN RAILROAD LINE TO CURVED TRACK OR EPI
USUAL METHOD OF DEPLOYMENT OF RAILWAY ARTILLERY AGAINST LAND TARGETS
CITY
RIVER
CITY
CURVED TRACK OR EPI
SPECIAL CURVED TRACK FOR SLIDING RAILWAY MOUNT SHOWING METHOD OF OBTAINING HORIZONTAL TRAVERSE
SECTION SHOWING DECK CONSTRUCTION OF THE CURVED TRACK OR EPI

Fig. 2. Special Curved Track for Aiming Sliding Mounts in Azimuth

The same gun can be used on either coast, or along any boundary to be defended, or with armies in the field. Moreover, if a landing at any point is accomplished by the enemy, the guns can be withdrawn to prevent capture, and relocated to prevent further advance of the enemy inland. No other country is so well adapted as our own to the use of this type of mount. Our great railway systems, built for heavy loads and totaling more than 310,000 miles, makes this type of artillery ideal for use in this country.

On the other hand, those opposed to the use of railway artillery for seacoast defense point out that existing types permit but a few degrees traverse of the gun for laying in direction, and that wide traverse can only be obtained by means of very elaborate platforms. Major caliber guns, so mounted, require many hours to install, and have a slow rate of fire, one shot in three minutes, as compared with one shot in forty seconds, the rate for fixed armament. They further contend that the temporary platform, upon which the mount must be placed to obtain satisfactory traverse, will settle out of level, making accurate fire doubtful.

It will be seen later that these principal objections are based upon the observation of mounts like the 10-inch *sliding* carriage, which was *built only for land warfare,* and that no allowance for the improvement of experimental types designed for seacoast defense has been made. It is the purpose of this article to endeavor to make clear the main problems encountered in the design of railway artillery for use against moving targets and to show how these problems have been and are being solved, in the work undertaken since the armistice.

Characteristics of a Mount Suitable for Seacoast Defense

What should be the characteristics of a railway carriage which will be suitable for seacoast defense purposes?

A consideration of the advantages of the fixed carriage and the disadvantages of the railway carriage built for land defense will indicate the characteristics which a unit must have in order to be acceptable to the service for use against moving targets. The conditions which must be fulfilled are as follows:

(*a*) *Elevation and Traverse.* The mount should permit sufficient elevation to develop the full power of the gun and provide wide traverse for laying the piece in direction, preferably 360 degrees.

(*b*) *Installation.* It should be capable of being rapidly installed and quickly removed from its platform.

(*c*) *Mobility.* It should be capable of being moved over the majority of railroads in the United States.

(*d*) *Rate of Fire.* The rate of fire should be equal to that of the fixed mount.

(*e*) In order that the full value of the railway carriage may be realized, the mount built especially for seacoast defense purposes should also be suitable to accompany an army in the field and have satisfactory characteristics for use against stationary targets.

Fortunately, it is possible to build a railway mount which will meet all the above mentioned requirements. It is the present aim of the Ordnance Department to so design each railway unit that it can be successfully used either as a land warfare or seacoast defense weapon, as the situation demands. This economy of materiel is considered one of the most important advantages of railway artillery, and one which should appeal strongly to those responsible for arming the nation at the minimum of cost.

Discussion

Platforms for Wide Traverse and Rapid Installation

The platforms used for the railway carriage to absorb the energy of recoil are varied. For guns not exceeding 8 inches in caliber, and howitzers not exceeding 12 inches in caliber, the platform can take a very simple form and yet permit wide traverse. It is possible to put a carriage

of this size into position in one-half hour and obtain 360 degrees traverse and fire.

In the case of mounts for land warfare like the 10-inch sliding railway mount where only limited traverse is necessary, the problem is also simple, since the gun always remains nearly parallel to the direction of the track, and the road bed itself can be utilized as the foundation.

The platform for a large cannon which provides wide traverse, is necessarily more elaborate. A comparatively simple one can be constructed of concrete. Simple concrete platforms are feasible for seacoast positions since they can be located at selected points in advance. A portable steel platform was built for the 14-inch gun railway carriage, Model E, which did not require the use of any concrete. This platform could be installed in about eight hours. Undoubtedly, future improvements and development will reduce this time materially.

It is a common fallacy to believe that unless the trunnions of the gun are level, accurate fire is rendered more difficult. If, however, the elevation quadrant used in laying the gun is provided with a cross level, no correction in range data is necessary. It is customary to provide field carriages with panoramic sights so mounted that they will automatically indicate the true azimuth of the gun, even though the wheels of the carriage are out of level. This mechanism has also been adapted to the railway mount, so that any initial "out of level" or subsequent settling of the platform is immaterial to the accuracy of fire.

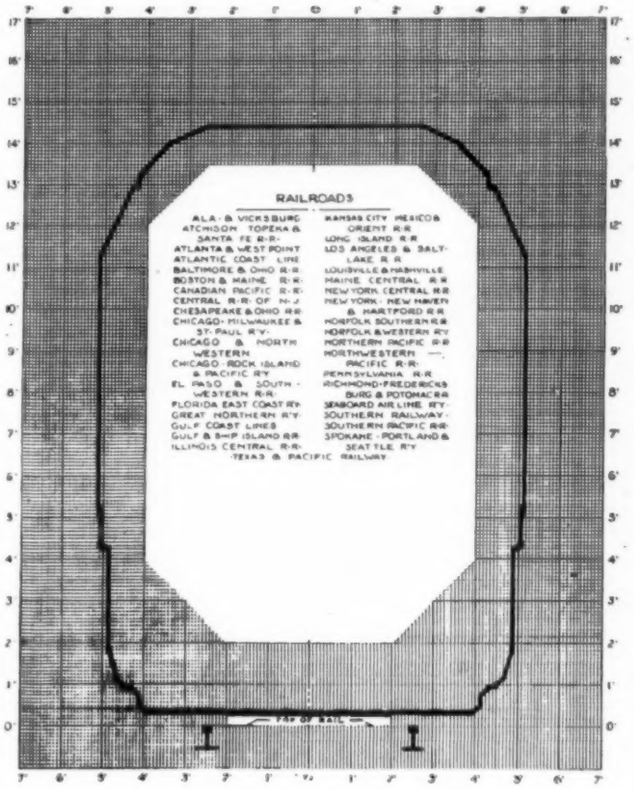


Fig. 3. Composite Clearance Diagram of American Railroads

Mobility

In order that the mount may be quickly transported from one place to another, it must not exceed the clearances permitted by various railroads. A standard diagram for all European railroads was adopted at the International Conference at Berne, in 1913. No such diagram has ever been adopted for the railroads of the United States, and it was, therefore, necessary to make a study of this subject before the construction of railway artillery could be started. The minimum clearances of the principal railroads of the United States were obtained by the Ordnance Department from the various railroads, and from this data a clearance diagram for the United States was made. This diagram is shown in Fig. 3. Fortunately, the railroads in the United States are built for much heavier loads than those of Europe, and the clearances are also more generous.

Rate of Fire

It has been stated that the railway mount cannot be successfully used for seacoast defense, due to its slow rate of fire. The rate of fire of fixed armament is about one shot in 40 seconds, as compared with a rate of fire of about one shot in 3 minutes for railway artillery constructed for land warfare. The rate of fire of a gun mounted "en barbette," or upon a railway carriage, is determined by the rapidity with which the gun can be elevated to the firing position and depressed to the loading position. It also depends upon the type of breech block used with the gun. Some types of breech blocks for 14-inch guns require 10 to 12 seconds to open and close, while there are other blocks for the same size gun which can be opened or closed in from 2 to 3 seconds. Another factor which determines the rate of fire of the carriage is the rapidity with which the projectiles and powder can be brought up to the carriage and rammed into the piece.

The first two factors, speed of elevation or depression, and time required to open and close the block, are independent of the type of mount used, that is, there is no reason why the elevating mechanism for a railway mount cannot be as efficient as one for a fixed carriage. The same type of breech block can, of course, be used with either type of mount. Therefore, in order to make the rate of fire of the railway carriage equal to that of the fixed carriage, it is only necessary to deliver the ammunition with sufficient rapidity to the breech of the gun and provide the necessary facilities for rapidly ramming it home. There is no inherent reason why this can not be accomplished. High rate of fire is not characteristic of mounts like the 10-inch sliding railway mount, just described, since it is not necessary for land warfare. By the use of electric power, which is now a part of the equipment of all modern fixed armament, the rate of fire of the railway carriage when it is placed upon its platform, can be made equal to the gun permanently mounted "en barbette."

14-inch Gun Railway Mount, Model E

In 1914 the Ordnance Department made its first attempt to construct a railway mount having characteristics suitable for seacoast defense work. This carriage was remarkable for the reason that it demonstrated the feasibility of firing a gun of this caliber from a temporary platform which could be laid in the field without the use of concrete. It provided all-round traverse. The platform consisted simply of two semi-circular steel castings having a total weight of 34 tons, laid upon a bed of about 18 inches of gravel. Steel stakes 18 inches long were driven around the periphery of the steel ring to prevent movement laterally. This carriage has been thoroughly tested by the Ordnance Department at Aberdeen Proving Ground, and by the Coast Artillery Board at Fort Story, Va., where moving targets were successfully fired upon at various ranges. General Johnson Hagood, U. S. Army, in his

report of the test, after suggesting certain mechanical improvements in the loading equipment to increase the rate of fire, concludes by stating that in his opinion the 14-inch railway mount, model E, is more satisfactory in its present state of development than any 14-inch fixed carriage now installed in the fortifications.

12-inch Railway Mount with New Experimental Platform Fig. 4

During the war the Department built in this country a number of 12-inch gun railway mounts of a French type known as the "Batignolles." These were excellent for use against stationary targets, and like the 10-inch sliding type, were extensively used in France. The carriage and its platform, however, provided only 10 degrees traverse of the gun for pointing. These units, therefore, could not be used by the service for coast defense on account of the small traverse. It was desired to convert them into all-round fire mounts, cheaply if possible. In order to accomplish this, a platform has been devised with which it is possible to rapidly traverse the mount through 360 degrees. This platform was constructed by utilizing the base ring and racer of a 10-inch Disappearing Carriage, Model of 1896. As this type of carriage has been declared obsolete and is being removed from the fortifications, a number of base rings and racers are available for this purpose. Certain modifications and additions to the existing parts were, of course, necessary to adapt them to the mount. The unit is run over the resulting platform and raised by means of screw jacks until the trucks can be removed. It is then lowered onto the platform and held in place by means of clamps and bolts. This platform was tested at Aberdeen Proving Ground in the presence of the members of the Coast Artillery Board, who were very enthusiastic over the results.

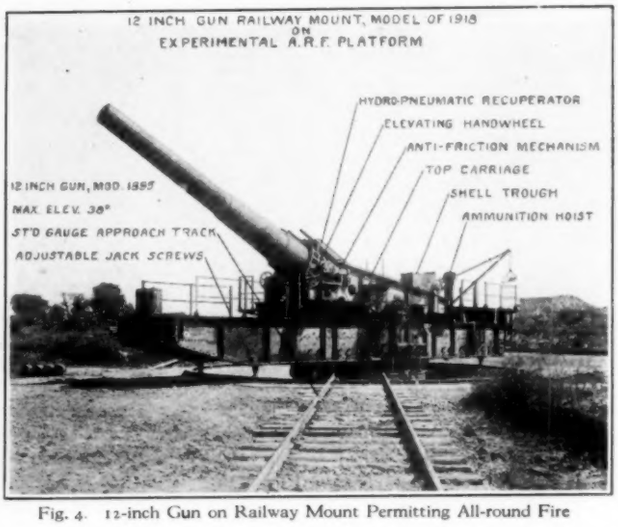


Fig. 4. 12-inch Gun on Railway Mount Permitting All-round Fire

Later Developments

12-inch 20-caliber Howitzer Railway Mount. Fig. 5

This unit, which has just been completed, incorporates the experience which was gained during the war not only from the design and construction of a large number of various types of railway carriages in this country, but also from a study of foreign mounts.

It is estimated that this mount can be placed in the firing position by a trained crew in less than one-half hour. Before firing it is necessary to raise it about 1 inch by means of special jacks built into the carriage and to place two short I-beams under the girders parallel to the tracks. It is then lowered to rest upon the platform, which consists of the I-beams, the standard railroad ties and the road bed. The outriggers, attached to the carriage, are then set against wooden floats buried in the ground. These prevent the carriage from moving horizontally. Although the unit is hand maneuvered throughout, it is expected that the rate of fire will be about one shot every 50 seconds. The piece will have a range of about 22,000 yards with a 700-pound projectile, and can be fired through 360 degrees traverse. This carriage should be equally suitable for use with a field army against stationary targets or for seacoast defense work. Recent studies show that an 8-inch 50-caliber gun can also be mounted upon this same carriage with but few modifications. The 8-inch gun so mounted will give a maximum range of 35,000 yards with a 200-pound projectile.

14-inch Railway Mount, Model of 1920. Fig. 6

The 14-inch railway mount, model of 1920, is being constructed to meet the requirements of the service for a high power mobile weapon which can be successfully employed against both moving and stationary targets.

The gun will have a maximum elevation of 50 degrees, which will give a corresponding range of about 40,000 yards with a 1560-pound armor-piercing projectile. It will be possible to fire the mount from several different platforms. For use against land targets it should be possible to go into position in less than one hour since no special foundation will be needed. To prepare the mount for firing it is raised by screw-jacks built in the girders until I-beams can be placed under each girder, as is done in the case of the 12-inch 20-caliber howitzer railway mount previously described. It is prevented from moving to the rear by means of outriggers. By moving the top carriage upon the girders, seven degrees traverse of the gun can be obtained for the adjustment of fire. It will also be possible to run the mount over a simple concrete emplacement, bolt it down and obtain 360 degrees traverse. For this purpose the carriage will be provided with a large ball-bearing attached to the lower side of the girder as shown in Fig. 6. Two small wheels will be located just in front of the rear trucks. When the ball-bearing is bolted to the concrete and the trucks have been removed, the mount can be turned in any direction by means of the two wheels which will bear on steel segments buried in the concrete. In this position it should be equivalent to any fixed carriage for coast-defense work. A structural steel field platform permitting 360 degrees traverse will also be furnished to enable the mount to be installed in any new position without the use of concrete.

The carriage will be provided with full electrical equipment for electric firing, lighting, traversing and loading the projectile and powder. Current will be furnished by a 25-kilowatt gasoline electric generator set located upon the front trucks of the mount. The design permits the 14-inch gun and its cradle to be removed from the mount and replaced without modification by the 16-inch 25-caliber howitzer, which can then be fired up to 65 degrees elevation.

Manufacturing Problems

During the war everyone came to realize that two to three years were necessary for the construction of major caliber guns, and that this time could not be appreciably reduced. The manufacture of large guns requires special equipment and can be undertaken only by plants designed especially for this work. Next to the gun, the cradle, with

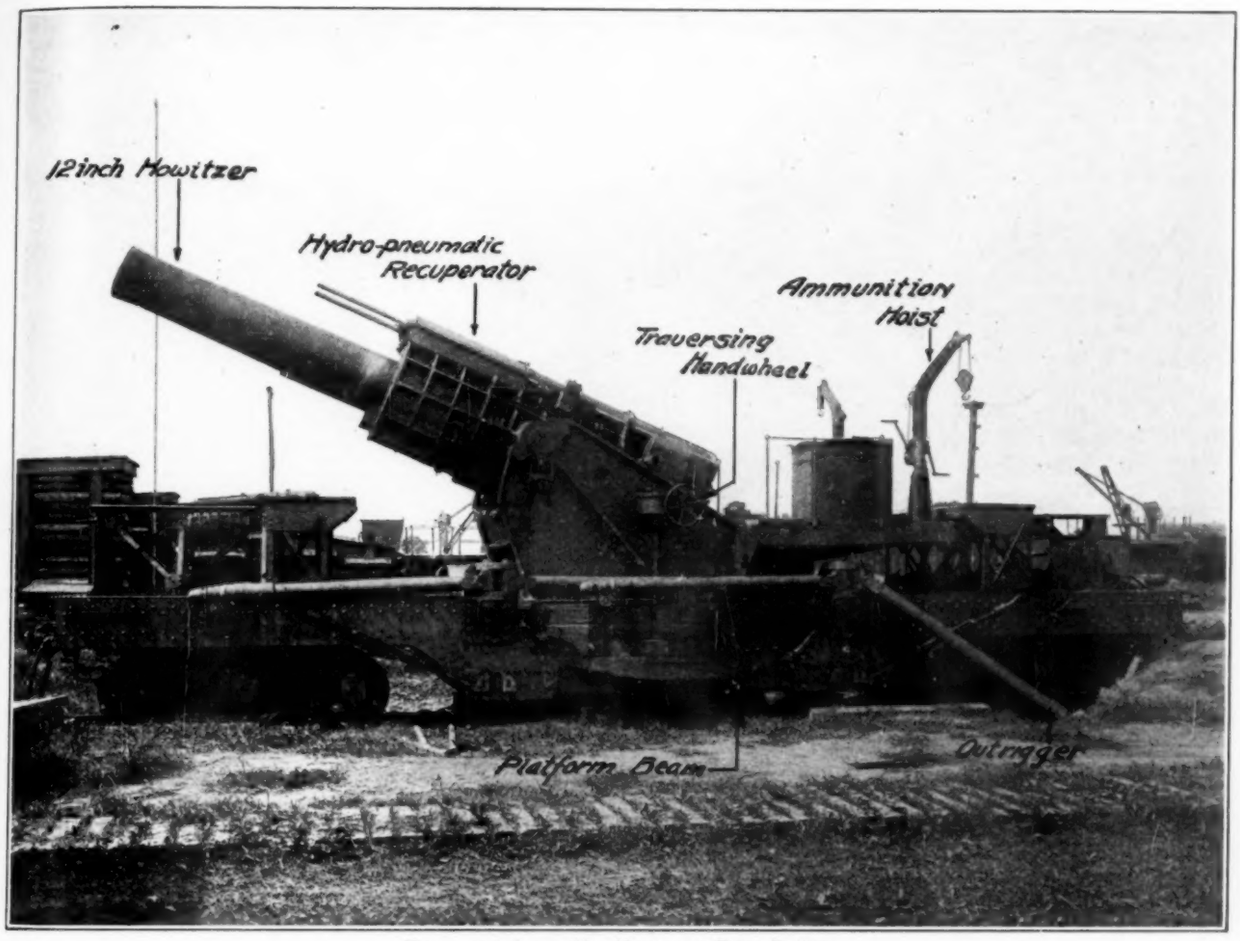


Fig. 5. 12-inch 20-caliber Howitzer in Firing Position

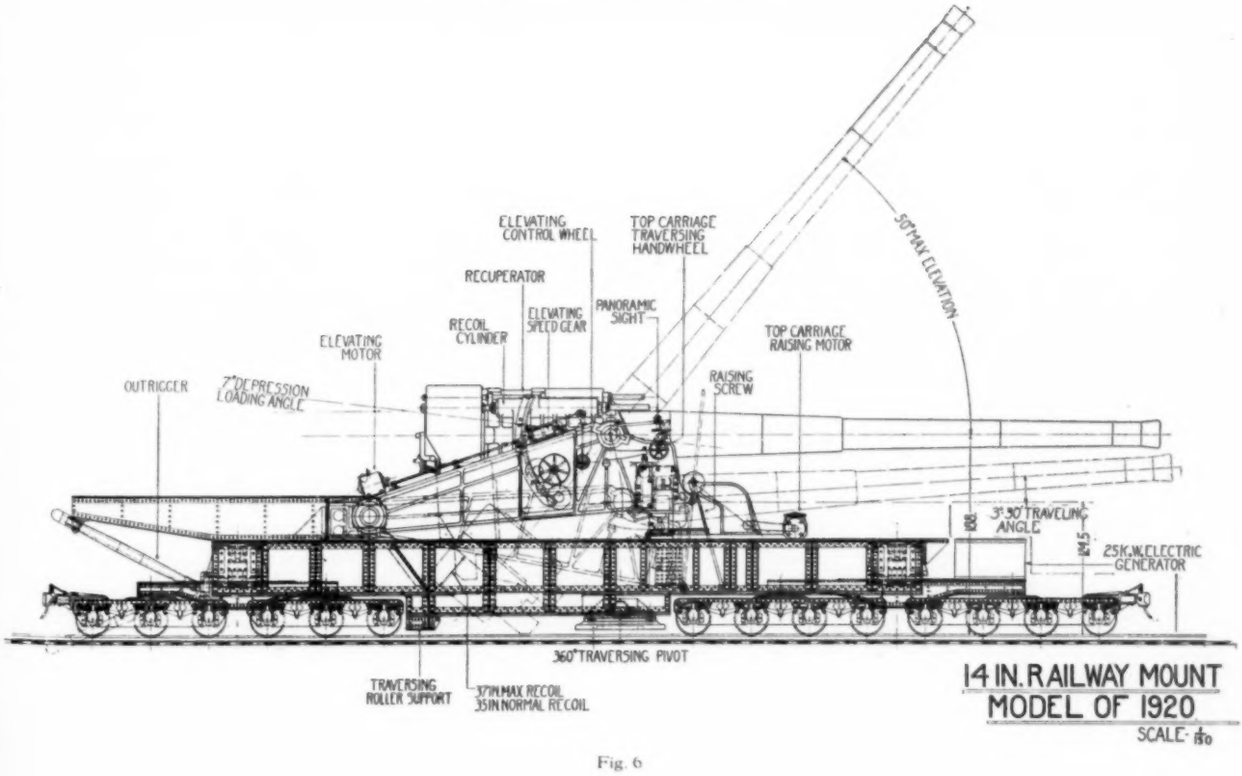


Fig. 6

its recoil and hydro-pneumatic counter recoil mechanism. is the most difficult part of the railway unit to construct. The experience of the war showed that the cradle production could not be expected before 18 months or 2 years. The great accuracy required in the recoil mechanism to control the energy of the gun after firing and the complicated hydro-pneumatic counter recoil system make this mechanism very difficult to construct. For these reasons a special shop has been equipped at Watertown Arsenal for the construction of cradle mechanism for major caliber guns. This shop is fully equipped with all special machinery required for the manufacture of cradles. A limited number of mechanics, especially trained for this work, will be employed upon the construction of such cradles as are built under the peace program. Fig. 7.

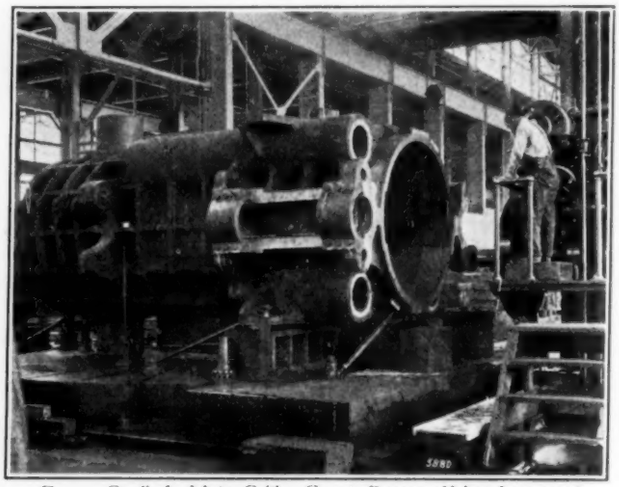


Fig. 7. Cradle for Major Caliber Gun, in Process of Manufacture at Watertown Arsenal

The remaining components of the railway unit can be readily constructed commercially. Locomotive companies are well equipped for the manufacture of the trucks required and deliveries can be obtained in large quantities within three months, even though the trucks are of special design. Commercial bridge companies can construct girders for the mounts, if suitably designed, starting deliveries within two months or less. Other parts, such as elevating, traversing and loading mechanisms, can be built in unlimited quantities by any machine shop with machine tools of sufficient capacity for the work.

It will therefore be appreciated that the quantity of railway artillery available during the first two or three years of a war will depend on the number of major caliber guns and cradles which are built in time of peace. The only railway artillery completed in this country in time for use during the World War utilized existing guns and cradle mechanisms.

The Railway Unit fully demonstrated its value as a weapon for land warfare during the World War. The necessity for this type of artillery is recognized by the War Department and the latest organization tables of the United States Army provide for its issue. Railway artillery can also be successfully used for coast defense, possessing many advantages over fixed armament, due to its mobility. In its present state of development it is generally more favored by experienced artillery officers than fixed armament for seacoast defense. A program for the construction of railway artillery for this purpose has been approved by the War Department and by Congress.

The Utility of Railway Artillery

Comments on Colonel Sherrill's Discussion

By

HOMER R. OLDFIELD
Major, Coast Artillery Corps

[In the September-October number of ARMY ORDNANCE there was printed a digest of an article by Colonel Sanderford Jarman, C. A. C., entitled, "Future Seacoast Defense Artillery," together with discussion thereon by Col. C. O. Sherrill, Corps of Engineers. The conclusions reached by Colonel Sherrill have been questioned by several officers of the Coast Artillery Corps, one of whom, Maj. Homer R. Oldfield, has replied to Colonel Sherrill's discussion in the following article which appears in the November number of the *Journal of the United States Artillery*. On account of its value in outlining the views of users of railway artillery matériel, we reprint it herewith practically in full for the benefit of the designers and manufacturers of this type of Ordnance.—ED.]

Unfortunately, many of the problems involved in seacoast defense have been clouded by individuals whose knowledge of the characteristics of the various heavy artillery types and of the technical, and even the tactical employment thereof is so limited as to lead them to very erroneous conclusions. Such misconceptions and lack of knowledge are by no means confined to the opponents of the employment of railway artillery.

Colonel Sherrill's opinions and conclusions are apparently based largely on his assumption that railway artillery mounts are inherently less accurate than fixed mounts on carefully leveled and very stable concrete bases. He makes certain other assumptions that are not justified. It therefore seems advisable to point out the misconceptions under which he is apparently laboring.

His assumption that railway artillery mounts are inherently less accurate than fixed mounts *is not* justified. Railway Artillery mounts are inherently as accurate as fixed mounts. This is a statement of fact and not an assumption. Colonel Sherrill apparently believes that the methods of pointing used with the two classes of mounts—fixed and railway—are identical. This is not the case.

In pointing fixed cannon, at least those now mounted, the whole carriage is pointed in direction by means of either a sight or an azimuth circle rigidly fixed to the non-recoiling parts of the carriage. The piece is pointed in elevation by means of either a range scale or a quadrant. Both are fixed with reference to the horizontal plane of the base of the carriage. Neither sights nor quadrants are cross leveled. A deviation from the level of the foundations which support the piece thus introduces errors which become serious when these foundations are badly out of level.

With mobile guns all pointing operations are absolutely independent of the level of the base ring and foundations. Quadrants are used to give elevations and are cross leveled so that they always read the actual quadrant elevation of

the axis of the bore. The panoramic sight is fixed to the non-recoiling part of the carriage but it is also connected to the tipping parts of the carriage so as to correct automatically for the lateral motion of the axis of the bore which occurs when the piece whose base is not level is elevated.

The various pointing devices are all of the same order of precision.

An unstable base or one very badly out of level might conceivably lead to increased dispersion due to a greater variation in jump from round to round. But that this is not the truth with railway artillery of present design, was amply demonstrated in France. The materials used there employed bases of the same relative stability, and their probable errors did not exceed those of our fixed mounts. Thus it is apparent that the relative inaccuracy claimed for railway mounts does not exist.

Their accuracy was demonstrated by American troops in France. Such troops fired thousands of rounds in combat. To determine their adaptability to moving target work only a test of their rate of fire and of their rapidity of traverse was required. All other characteristics were fully known.

The rates of fire of the railway mounts now built are somewhat slower than those of fixed mounts of corresponding calibers. This is due to the fact that the railway artillery so far built was built for use in land warfare. Minor alterations are all that are necessary to place these on an equality, and these alterations are already under test.

It is apparent to any one having a knowledge of the characteristics of the two classes of armament that there is no inherent reason why either should be superior in rate of fire.

The statement with respect to the rate of fire obtained with the 14-inch railway mount at Fort Story is entirely correct. It is of interest to note in this connection that the rate of fire of the 12-inch long range fixed mount battery at Fort Hancock, New Jersey, tested shortly prior to the 14-inch railway mount and by the same officer personnel, was no faster. Both mounts had the same defects. The fixed mount battery has since been modified to increase its rate of fire. The same improvements and many others are being incorporated in the new design for the 14-inch fifty caliber railway mount.

The rate of fire of the 14-inch and 16-inch guns already mounted in our defenses can not be compared with those of railway artillery as the elevations and ranges of the former are very limited. No comparison as to rates of fire is fair unless the elevations used, the total number of rounds fired, and the year the mount was designed is given. It would be interesting to learn the occasions on which the rates of fire mentioned by Colonel Sherrill were actually obtained with 14-inch and 16-inch guns. It is believed that forty seconds per round per piece is optimistic for battle conditions. The only definite data available to the writer tends to show that the 14-inch guns have a rate of sustained fire of about one shot per minute as the maximum, and for the 16-inch gun, the maximum rate of fire is about one shot every one and one-half minute. Furthermore these rates can only be obtained when very small angles of elevation are used.

The rate of fire of the railway artillery pieces now being designed can not be definitely stated, but there are reasons to suppose that it will be about one shot per piece per minute. It therefore appears that as regards rate of fire and accuracy there is practically no difference between the guns and mounts of the two types now being designed.

Colonel Sherrill states that, "Guns in fixed emplacements have the great advantage of being located just where they are needed. . . ." This statement can not be agreed to. In fact it is believed that few, if any, of the fixed mount cannon now emplaced are located just where they are needed. It is believed that most of them could be much more advantageously located. The best position under today's conditions may be a faulty one under tomorrow's conditions. Mistakes made in time of peace can be remedied to some extent at the out-break of war if our armament be mobile, but not if it be installed on fixed mounts.

In locating fixed guns we are restricted to definite tracts owned by the United States Government. Mobile mounts can be located anywhere. In most localities the proper dispersion of fixed armament can be secured only by purchasing excessively large tracts. Thus when fixed mounts are being installed they are very apt to be located not on the best site but on a limited government owned tract.

The soothing effect on the inhabitants that he mentions is doubtless of some benefit but it also leads to the exact numbers, calibers and positions of the guns being known quite widely and thus, in the general case, by all probable enemy nations.

The difficulties of shifting mobile armament comparatively long distances are not over-stated. There are limitations which only intensive study of particular cases can bring out. Impossible claims have been made in this regard by some individuals. The value of mobility should not be thrown away, however, simply because there are practical limits to its use. Within safe limits this mobility is of very great value.

The writer has served several years with fixed mounts and has been actually serving with or closely connected with railway artillery since January, 1918, and is unaware of the disadvantages which it is claimed pertain to railway artillery once it is in position. He is unaware likewise of the advantages claimed for fixed artillery. The limitations of some of the railway artillery designed during the war are admitted, but it should not be forgotten that all fixed mount artillery now installed has its limitations. Comparing calibers, the railway artillery is somewhat slower in its rate of fire. This drawback applies only to present mounts and will largely disappear when these mounts are modified in much the same manner as many of the fixed mounts have recently been modified. Caliber for caliber, the railway artillery, with one or two exceptions, ranges from 50 to 100 per cent farther. It can be emplaced in positions that can be well hidden, whereas Colonel Sherrill has only to consult the records of his own office to find that fixed mounts of the types now installed have yet to be successfully camouflaged.

His statement that railway artillery mounts, once they are spotted, can not be withdrawn from position before they are destroyed, is somewhat misleading. That the mount probably can not be withdrawn while under a severe fire is entirely correct. The experience of the World War all goes to show that actual destruction of artillery material is very difficult, but that neutralization of material by forcing the personnel to take cover is comparatively simple. A railway piece, once located and adjusted on, probably would be neutralized during the time fire is kept on it. In general, however, it could be moved between phases of the combat and be reinstalled in a position unknown to the enemy during the next phase. Fixed mount pieces once located can be neutralized at any time the enemy desires. Certain railway guns in the World War were located by the enemy and neutralized every time they attempted to shoot. When moved to a new position unknown to the enemy, they were often able to fire without being subjected to enemy fire.

In view of the above remarks about the rates of fire(the remarks about the possibility of a ships zig zagging between shots and thus rendering fire delivered at 3-minute intervals less accurate and less easily corrected by an aeroplane observer are hardly pertinent. It is, however, of interest to point out that the accuracy of fire at a moving target is, within certain limits independent of the length of time between shots. This accuracy depends upon the predicting intervals, and not upon the interbal between shots. Some methods of vessel tracking have recently been proposed in which the interval between shots is of some importance, but they are not yet adopted and in no known method is this interval of vital importance. Colonel Sherrill states that "The railways along the coast are not suitably located for the effective use of railway guns except in a limited number of places, and even in these few places they are often of a light type not adapted to carrying major caliber railway mounts." The accuracy of this statement is challenged. The writer has made some studies along this line and just the reverse appears to be the case. There are few localities of importance on the Atlantic coast north of Wilmington, North Carolina, believed to afford desirable sites for the installation of primary armament for coast defense purposes that can not be reached by the .50-caliber railway mount now under construction. Most of these are small islands. The writer never has advocated the use of railway artillery on restricted sites, particularly on small islands. Some strengthening of bridges might be necessary in a very few localities, but no strengthening of track will, in general, be necessary.

The remarks about improvised fire control installations are well taken. No argument is necessary to show that the requirements in this respect are independent of the type of mount used.

The remarks about intermediate caliber armament are well taken if he is referring to harbor defense alone. The only types of secondary armament now mounted on railway trucks are 7-inch, 8-inch, and 10-inch guns. 10-inch guns are on sliding mounts and are of very limited utility in seacoast defense. The 8-inch guns are, however, of greater power and range than any guns now in existence on wheeled or caterpillar mounts, and should be the most valuable against enemy warships supporting a landing between the harbor defenses.

The suggestion that 6-inch, 8-inch, and 10-inch guns recently declared obsolete be reinstalled as intermediate armament in our coast defenses is believed to be most unwise. These guns have demonstrated their unsuitability for the purpose. The principle of using obsolete cannon for the defenses of our seacoast is one that will appeal to very few.

The remarks about the difficulty of camouflaging railway tracks are well taken. It should be remembered, however, that fixed armament fires ammunition too, so that, unless expensive concrete magazines be installed as part of the emplacements, some railway trackage will be necessary for ammunition supply, and that although difficult, railway trackage can be successfully camouflaged. The writer inspected several German railway positions of some years standing that were never discovered by the Allies.

Recent Investigations at the Bureau of Standards

FOR a great many years the chilled iron wheel has been used almost exclusively in freight car service in the United States. This wheel, as is well known, is produced by casting the iron in a mold having a metal rim in contact with the tread and flange of the wheel. This cold rim chills the casting at these points, thus producing a surface which is very resistant to wear. Stresses are naturally set up due to the casting method and the wheels must be very carefully cooled after removal from the sand. The service given by these wheels has been very satisfactory even under loads which have increased rapidly within the last few years, particularly since the introduction of the high-capacity steel car.

Recently, however, failures of such wheels have occurred at the foot of long and steep grades, and it has seemed likely that these breakages were caused by unequal stresses set up within the wheel through the heating of the rim produced by the long brake application. In order to determine the facts in the case, the Bureau, in co-operation with the makers of these wheels, started a complete investigation of the subject. The apparatus upon which the tests were conducted is very ingenious and consists of a suitable framework supporting an axle upon which the wheel is mounted in its normal condition. This axle is kept cool by water circulating through it, while the rim of the wheel is heated by an iron resistor placed close to but insulated from the tread of the wheel. By varying the amount of current passing through this resistor, the temperature of the rim of the wheel may be regulated. By means of numerous thermocouples the temperatures at many locations on the wheel's surface may be determined. At the same time, strain gage measurements are made, indicating the elongation or contraction that is taking place at any point. In this way any unusual temperature or stress conditions are easily discovered. It may be of interest to note that a number of the wheels failed under the temperature conditions imposed by this test. The results of the chilled iron wheel investigation have proven so interesting that the investigation is being extended to other forms of car wheels and data of much value will undoubtedly be secured.

Analysis and Microscopic Examination of Samples of Ancient Armor

Considerable interest has always been manifested in the processes employed in bygone days for the production of materials and devices, particularly as some of these appear to excel in certain qualities those produced by our more elaborate methods today. It is popularly supposed that there were numerous secrets connected with these ancient processes which have been lost to us, and that the employment of these now unknown methods was the cause of the excellent finished products. The Bureau, for instance, is continually receiving inquiries concerning methods for the hardening or tempering of copper. As a matter of fact, copper is hardened and tempered to-day, producing exactly

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Standardization of War Contracts

By

P. A. GALLEHER
Member A. O. A.

[Major Galleher has rendered a real service to American industry in reducing to concrete form the terms and conditions under which manufacture for Government account should be undertaken in national emergencies. Brig. Gen. William S. Peirce, in addressing the members of the Army Ordnance Association at the Aberdeen Proving Ground on October 22, 1920, said, "There is hardly anything more important to decide than the types, the various types, of contracts which from our experience would be best to use in the recurrence of another emergency." It should be the purpose of every Ordnance manufacturer to assist by the consideration of forms submitted for discussion and by every possible means in the adoption of a uniform war contract system.—ED.]

THE subject of contract standardization as applied to the procurement of war supplies has been considered from time to time by various administrative agencies of the Government. What progress has been made toward contract uniformity was accomplished to a large extent during the strenuous days of war and should now be carefully reviewed in the light of the experience gained by the expenditure of billions of dollars in the procurement of war material.

The American manufacturer can render no more valuable contribution to the industrial preparedness of the nation than by *co-operating in the consideration and adoption of a uniform contract system*, such a contract standardization as will meet all the demands for efficiency in modern business and at the same time be fair and equitable to the Government and to the contractor.

Any real consideration of such a broad question must have as its foundation a thorough knowledge of the existing Federal statutes affecting the negotiation of public contracts. An eminent Justice of the Supreme Court of the United States has said: "Our statute books are filled with Acts authorizing the making of contracts with the Government through its various officers and departments, but in every instance the person entering into such a contract must look to the statute under which it is made and see for himself that his contract comes within the terms of the law." Reference to a few of the essential statutory provisions will suffice to show the extent of the power to create binding obligations in behalf of the Government.

Source of Contracting Power.

The power of the Secretary of War to contract for supplies and services necessary to the conduct of the military establishment arises from Section 3714, Revised Statutes of the United States, which provides: "All purchases and contracts for supplies or services for the military and naval service shall be made by or under the direction of the chief officers of the Departments of War and of the Navy respectively."

Extension of Contracting Power.

The National Defense Act of June 3, 1916, as amended by the Act of June 4, 1920, gives to the President a broad power to be used in time of war or when war is imminent. Under these statutes a contractor may be compelled to manufacture products for the United States and to give preference to such work, all at reasonable prices to be fixed by the Government.

The Food Control Act of August 10, 1917, authorizes the President to requisition foods, feeds, fuels and other supplies necessary to the support of the army, and provides that a just compensation shall be paid therefor by the Government. The Acts of March 23, 1910, March 4, 1915, and August 29, 1916, authorize the Chief of Ordnance, the Quartermaster General, the Chief Signal Officer, and the Surgeon General to make informal contracts under such regulations as they may prescribe, provided performance is to be completed within sixty days or the amount involved is not in excess of five hundred dollars.

Limitation of the Contracting Power.

Section 3709, Revised Statutes, requires that contracts shall be made only after advertisement for proposals, except in cases where immediate delivery is necessary. Section 3732, Revised Statutes, requires that a contract shall not be made unless the same is authorized by law, or is under an appropriation adequate to its fulfillment. Section 3744, Revised Statutes, requires that contracts shall be reduced to writing and signed by the contracting parties with their names at the end thereof.

It must be apparent that compliance with all statutory provisions during a period of complete industrial and military mobilization is a most difficult problem. Assuming, however, that such compliance is possible in time of war, there is still the practical difficulty of negotiating and preparing without delay thousands of contracts for all kinds of material. Experience in the war has shown cases in which one contractor entered into a number of contracts with the Government, some on a fixed price basis, others on a cost plus profit basis, some providing that the Government would furnish all the material, others requiring the contractor to purchase the material, some providing for the assessment of damages for delays, others containing no reference to the question of delays, some protecting the contractor against fluctuations in the prices of raw material and others requiring the contractor to take the burden of all changes in market conditions. Such a variety of contract obligations under agreements covering the same general class of material if, of course, not desirable.

Any attempt, however, to bring uniformity out of these different classes of contracts will of necessity lead to discussion of the following:

The Liquidated Damage Clause.

The unusual conditions which exist in time of war make the imposition of a penalty for delays an unjust requirement in many cases. For example, the many classes of priority orders issued by the War Industries Board, the Railroad Administration, the Fuel Administration and other agencies of the Government, have in the past made it practically impossible for a contractor to undertake to make delivery at any specific time or place.

It would seem that the liquidated damage clause should not be used in time of war except in cases where the con-

tracting officer is not satisfied that the contractor will use its best efforts to make deliveries on the dates specified in the agreement.

The Actual Damage Clause.

There are cases in which the liquidation of damages for delays in delivery does not afford an adequate compensation or serve any useful purpose. For example, in contracts for fuel urgently needed at a military post the Government desires the prompt delivery of the fuel and not compensation for delays. In these cases the contract should contain a provision by which the failure to deliver at the time agreed upon would give to the Government the right to purchase in the open market and to look to the original contractor for the payment of any increased cost.

The Fluctuating Price Clause.

The uncertain market conditions in time of war make it impossible for a contractor to submit a bid on a fixed price basis without making ample allowance in the bid for possible fluctuations in the cost of raw material. This results in the Government being required to pay a price much in excess of that which would prevail if the contractor were properly protected against unforeseen changes in material costs. This protection is offered by the fluctuating price clause, which authorizes the adjustment of the fixed price either upward or downward, depending upon the audit at the completion of the contract to determine whether the raw material costs were greater or less than those estimated at the time the agreement was negotiated.

The Over-run Clause.

There are many contracts which cannot be performed by the delivery of the exact quantity of material required in the agreement. For example, a contract for the manufacture of five million pounds of picric acid would hardly be completed by the delivery of exactly five million pounds of acid, and a discrepancy of from one to five per cent either over or under the contract requirement might reasonably be expected. In such cases the use of a clause by which the contractor is considered to have completely performed by the delivery of the entire contract quantity, plus or minus a certain percentage thereof, would seem desirable.

The Unauthorized Informal Contract.

In time of war it is difficult to comply with the provisions of Section 3744, Revised Statutes, which requires that every contract shall be reduced to writing and signed at the end by both parties. By experience it is learned that many orders are placed by telegrams and letters, and, although accepted by the contractors, they cannot be considered as contracts, as they are not signed at the end by both parties, as required by the statute.

It is believed that Congress should be asked to enact legislation by which *the use of an informal contract would be authorized in time of war, such contracts to be drawn in accordance with such regulations as might be prescribed, regardless of the amount involved or the period of performance.*

In considering the various kinds of contract obligations, it might be well to recall that there are certain well-defined limits beyond which standardization is not possible. An order for the manufacture of one million pounds of T. N. T. would not be placed under the same form of contract as an agreement for the delivery of one million pounds of beef, and a prudent business man would hardly use the same form of agreement to procure a locomotive as would be desirable in purchasing a hundred gross of needles. *The first limit to standardization is, therefore, found in the class of material to be procured;* in other words, a uniformity in contracts for Ordnance material, a uniformity in contracts for Quartermaster supplies and so on through all the classes of war supplies.

The next limit to standardization is found in the method of procurement to be employed in obtaining any material of one general class. For example, Ordnance material has been purchased under the following kinds of contracts:

(*a*) Fixed price;
(*b*) Cost plus percentage profit;
(*c*) Cost plus fixed profit;
(*d*) Cost plus adjustable profit;
(*e*) Cost plus nominal profit;
(*f*) Agency;
(*g*) Operating.

There are many cases where the use of a cost plus profit contract is preferable to the fixed price agreement, as for example, where the production is novel and the contractor has no past experience upon which to base a price, where the production involves manufacturing under constantly changing specifications, where the contractor lacks sufficient capital and equipment, and where construction work is desired for which the cost plus contract has been standard for many years.

From the above it is, of course, apparent that absolute uniformity even when contracts are for the same class of material is not possible. It is believed, however, that *a large percentage of contracts placed in time of war should be on a fixed price basis.*

The standard fixed price agreement to be adopted should, of course, possess all possible advantages to the Ordnance manufacturer and to the United States. The form of contract submitted below, as a basis for discussion, contains some provisions which are particularly favorable to each of the contracting parties, for example:

Advantages to the Contractor.

(*a*) Provides for the payment of any increases in the cost of raw material, thereby limiting the contractor's obligations for material to the costs estimated at the time the contract was made.

(*b*) Provides for the payment of any increased costs due to the settlement of labor disputes.

(*c*) Assures the payment of the profit estimated in the original bid by the adjustment of all fluctuations in material and labor costs.

(*d*) Provides for the payment of losses due to the delay of the Government in furnishing material, these losses being estimated in advance and paid in the form of liquidated damages.

(*e*) Provides that delays in delivery due to all unavoidable causes shall not be made the basis of the assessment of damages.

Advantages to the United States.

(*a*) Permits the contractor to submit lower bid, as allowance for uncertain market conditions affecting material and labor is not necessary.

(*b*) Meets the usual objection to the cost plus percentage profit agreement, in that increased material and labor costs do not, under the suggested form, increase the profit.

(*c*) Gives to the Government the benefit of all savings in material and labor costs.

(*d*) Gives to the Contracting Officer the power to determine, without review, the amount of all adjustments in price, whether upward or downward.

Proposed Form of Standardized Government War Contract

THIS AGREEMENT, made this_____day of_____ between_____

_____

of the first part (hereafter called the "Contractor"), and the United States of America by_____, U. S. Army (hereafter called the "Contracting Officer"), acting by authority of the Chief of Ordnance U. S. Army and under the direction of the Secretary of War, of the second part.

WITNESSETH:

WHEREAS, a state of war exists, constituting a national emergency, and

WHEREAS, the Act of Congress, known as the National Defense Act, approved June 3, 1916, as amended by the Act of June 4, 1920, confers upon the President of the United States certain powers to be exercised through the head of any executive department in time of war.

NOW, THEREFORE, under the provisions of the statutes of the United States, and pursuant to orders by which the requirements of advertisement for proposals are dispensed with and contracts in the form hereof duty authorized, it is provided:

1. THE CONTRACTOR COVENANTS AND AGREES TO AND WITH THE PARTY OF THE SECOND PART:

Articles

(*a*) That it will deliver to the United States the following described articles:

_____

_____

_____

_____

_____

_____

Packing

Said articles to conform strictly to the specifications and drawings hereto annexed and made a part hereof, with such changes therein as may hereafter be directed by the Contracting Officer said articles to be suitably packed, boxed and marked by the Contractor in the manner directed by the Contracting Officer, and to be delivered at_____

Deliveries

on the following dates and in the quantities specified:

_____

_____

_____

Care of Government Property

(*b*) That it will use due and proper care to protect all property of the United States in its possession, such property to be suitably marked for identification and to be kept separate and apart from all other property.

Storage

(*c*) That it will provide at its plant adequate storage facilities and will store at the risk of the United States but at its own cost, all articles and material which the United States may not desire to have shipped. *If, however, the quantity of material stored by the Contractor shall be in excess of_____the storage of such excess quantity shall be made the subject of compensation in the manner hereinafter provided.*

Patents

(*d*) That it will indemnify and save the United States and all persons acting under them harmless from and against all and every demand or demands of any nature or kind on account of the adoption of any plan, model, design or suggestion, or for or on account of the use of any patented invention, article or appliance that has been or may be adopted or used in c about the construction of said articles, and to protect and discharge the United States from all liability on account thereof by proper releases from the patentees and by bond, if required, or otherwise to the satisfaction of the Chief of Ordnance.

Liens

(*e*) That it will waive and release all lien or right of lien now existing or that may hereafter arise for work or labor performed or materials furnished, or for any other reason or cause under this contract, under any lien laws, State or Federal, upon any component parts, materials, supplies, and the like coming into its possession, which it is herein contemplated shall presently or ultimately become the property of the United States, and the Contractor agrees not to create or suffer to be created any mortgage, lien, pledge, attachment, or other encumbrance upon any such component parts, material, supplies, or other property in its possession intended to form a part of the articles to be delivered under this contract. In the event that such mortgage, pledge, lien, attachment, or encumbrance is created, the Contractor agrees to pay and discharge, or if it disputes the validity of the claim out of which such encumbrance arises, immediately to bond same to the end that all property shall at all times be and remain free from all encumbrances.

Inspection

(*f*) That it will furnish reasonable facilities and assistance in order that all materials and component parts unused or in process, the machinery, the equipment, and the plant used in the performance of this contract, and the finished articles, shall at all times be subject to inspection by persons designated by the Chief of Ordnance.

Rejection

(*g*) That it will replace all materials, component parts and articles which may be rejected on inspection, if directed so to do by the Chief of Ordnance. In event of the rejection of materials or component parts because of failure to comply with the requirements of this contract, the decision of the Chief of Ordnance with respect thereto shall be final.

Preference

(*h*) That it will give the performance hereof preference and priority over any other work except work heretofore given preference or priority by the United States. It shall, from time to time, and whenever requested to do so, furnish the Contracting Officer reports on the progress of the work.

Precautions

(*i*) That it will provide, in addition to the ordinary pre autions heretofore adopted by the Contractor for the guardin and protection of its plant and work, such additional watchmen and devices for protection of its plants and property and the work in process for the United States against espionage, acts of war, and of enemy aliens as may be required by the Chief of Ordnance. The Contractor shall, when required, report to the Chief of Ordnance, the citizenship, country of birth, or alien status of any and all of its employees. When required by the Chief of Ordnance the Contractor shall refuse to employ, or if already employed, forthwith discharge from employment and exclude from its works any person or persons designated by the Chief of Ordnance for cause as undesirable for employment in a plant engaged on work for the United States.

Exploitation Forbidden

(*j*) That it will refrain from exploiting by publicity, or otherwise, its products manufactured in pursuance of this contract, and of any and all contracts and orders heretofore or hereafter entered into or placed with the Contractor, and its products manufactured under any arrangements with the United States whatsoever, and the Contractor agrees to refrain from in any way publicly advertising the fact of the manufacture of said product, and to refrain from publishing, or causing, or allowing to be published, any photographs, drawings, written or printed matter, or other data disclosing the articles, or parts of the same, or the process of manufacture, or the plans of the Government, or any information concerning the same or which shall result in such disclosure. The Contractor agrees to submit to the Chief of Ordnance all pictures or printed matter showing, describing, or in any way relating to the progress of the work to be prosecuted under this contract, and under any and all contracts and orders heretofore or hereafter entered into or placed with the Contractor, or under any arrangements with the United States whatsoever, which he may desire to publish, before publishing the same, and the Chief of Ordnance may prohibit such publication. The Contractor further agrees to refrain from giving any information whatsoever relative to any experiments that may be carried out by it at the instance of the United States.

Sub-contracts

(*k*) That it will insert in every contract hereafter made in relation to the performance of this contract, a provision that such contract may be assigned by the Contractor and that it relates to this contract. The Contractor shall, from time to time, upon request, exhibit to the Contracting Officer any and all contracts made in connection with the performance of this contract.

Payments

2. THE UNITED STATES COVENANTS AND AGREES TO AND WITH THE PARTY OF THE FIRST PART:

(*a*) That it will pay to the Contractor for the articles as and when delivered, in accordance with the provisions of this contract, the_____

_____

_____

_____

Reduction for Errors and Latent Defects

which amounts are *subject to adjustment either upward or downward* in accordance with the following:

(*a-1*) Payments shall be subject to correction for errors, if any, and shall be refunded in event of the discovery of latent defects in the articles delivered hereunder.

Adjustment for Fluctuations in Material Costs

(*a-2*) *The purchase price, as set forth above, is based upon the following estimate of the prices of materials entering into the manufacture of the articles:*

_____

_____

_____

_____

Upon the completion of this contract or upon its termination by the United States, the actual cost of the materials listed above, purchased by the Contractor and used in the performance of this agreement (other than materials furnished by the United States and unused materials on hand at the time of termination or completion), shall be determined by the Contracting Officer. If such actual cost shall exceed the estimated cost as set forth above, the purchase price for the articles delivered and accepted shall be increased by an amount equal to such excess. If, however, such actual cost shall be less than the estimated cost as set forth above, the purchase price shall be reduced by an amount equal to such difference. The Contractor shall not purchase any of the materials listed above without the approval of the Contracting Officer, and the increased cost of any materials purchased without such approval shall not be included in determining the actual cost in the manner described above In computing actual cost, materials furnished by the United States shall be included at the prices shown in the above schedule. The decision of the Contracting Officer as to the amount of such addition or deduction shall be final and conclusive upon the parties hereto.

Adjustment for Changes in Labor Costs

(*a-3*) A fair addition shall be made to the purchase price if as a result of the settlement of labor disputes by the Secretary of War in the manner hereinafter provided, or as a result of an executive order of the President of the United States, the Contractor is required to pay labor costs higher than those theretofore prevailing in the performance of this contract, but if, on the other hand, the settlement of such labor disputes shall reduce the labor costs of the Contractor, a fair deduction shall be made from the purchase price. *The decision of the Contracting Officer as to the amount of such addition or deduction shall be final and conclusive upon the parties hereto.*

Adjustment for Changes in Specifications

(*a-4*) A fair addition shall be made to the purchase price if changes made in writing from time to time by the Contracting Officer in the drawings and specifications attached hereto, or any revision thereof result in an increased cost to the Contractor. If, however, such changes reduce the cost to the Contractor, a fair deduction shall be made from the purchase price. The decision of the Contracting Officer as to the amount of such addition or deduction shall be final and conclusive upon the parties hereto.

Adjustment for Storage Facilities

(*a-5*) *A fair addition shall be made to the purchase price if the Contractor is required to provide storage facilities for property of the United States in excess of_____The decision of the Contracting Officer as to the amount of compensation for such storage facilities shall be final and conclusive upon the parties hereto.*

Adjustment for Delays in Delivery

(*a-6*) A deduction shall be made from the purchase price if the Contractor shall be in unexcused default in the delivery of articles in strict accordance with the schedule of deliveries set forth herein. This deduction, which is not imposed as a penalty, but as a liquidation of actual damages, shall be calculated at the rate of one-thirtieth of one per cent of the purchase price of each article for each day of default in delivery. The Contractor shall, however, *not be considered as in default if the delay is due to causes beyond its control, and the decision of the Contracting Officer as to whether the Contractor is or is not in default, shall be final and conclusive upon the parties hereto.* When one or more parts of an article or articles of a set or lot are not delivered on the proper date, the complete article or the entire set or lot, as the case may be, shall be classed and considered as undelivered for the purpose of calculating liquidated damages.

Adjustment for Delays in Furnishing Material

(a-7) An addition shall be made to the purchase price if the Contractor has been delayed in the conduct of manufacturing operations by the failure of the United States to deliver the material which it undertakes to furnish the Contractor under the provisions of this agreement. This addition, which shall not be considered as a penalty but as a liquidation of actual damages, shall be calculated at certain rates for each day of delay resulting in loss to the Contractor, namely:

_____

The decision of the Contracting Officer as to whether a delay in furnishing material by the United States has resulted in loss to the Contractor shall be final and conclusive upon the parties hereto.

Reduction for Material Furnished

(*a-8*) A deduction shall be made from the purchase price if the United States shall furnish material and component parts in addition to the material described in the schedule attached hereto (material which it undertakes to deliver without cost to the Contractor.) Such deduction shall be the estimated cost of such materials and component parts, not shown on the attached schedule, f. o. b. Contractor's plant, to which should be added demurrage, storage, cartage and switching charges. The decision of the Contracting Officer as to the amount of such deduction shall be final and conclusive upon the parties hereto.

Adjustment for Variance in Total Deliveries From Contract Quantity

(*a-9*) An addition shall be made to the purchase price if the Contracting Officer elects to accept the entire quantity of articles provided herein, plus_____per cent thereof. This addition shall be calculated at the same unit prices as set forth herein. If, however, the Contracting Officer elects to consider the contract as completed by the delivery of the entire quantity of articles less_____per cent thereof, a deduction shall be made in the purchase price, which deduction shall be calculated at the unit prices set forth herein.

Material to Be Furnished Without Cost

(*b*) That it will furnish without cost to the Contractor the materials and component parts listed on the schedule attached hereto and made a part hereof, in such quantities as may be requisite for the performance of this contract. The United States may at its option furnish to the Contractor other materials and component parts, provided the Contractor has not previously contracted in good faith for the purchase of such materials and component parts.

3. IT IS MUTUALLY AGREED BETWEEN THE PARTIES HERETO:

Termination

(*a*) That the Chief of Ordnance may at any time notify the Contractor that any part or parts of the articles then remaining undelivered shall not be manufactured or delivered, and the Contractor shall, upon receipt of such notice, immediately discontinue all work of every kind and description being performed under this contract. In the event of such complete or

partial termination, the United States shall inspect and accept all completed articles then on hand, and shall pay to the Contractor the price fixed herein for all articles so inspected and accepted. If at the time of such termination the Contractor shall not be in default the United States shall also pay to the Contractor the cost of the materials and component parts purchased for the performance of this contract and then on hand in an amount not exceeding the requirements for the completion of this contract, and also all costs shown by the Contractor to have been theretofore necessarily incurred in the performance of this contract and remaining unpaid. To the above sums may be added such sums as the Chief of Ordnance may deem necessary to fairly and justly compensate the Contractor for work, labor and services rendered under this contract, and the United States shall protect the Contractor in respect to all obligations incurred necessarily and solely for the performance of this contract of which the Contractor cannot otherwise be relieved. *The decision of the Contracting Officer as to whether the Contractor is or is not in default at the time of such termination shall be final and conclusive upon the parties hereto.*

Labor Disputes

(*b*) That the Contractor shall in the event that labor disputes arise affecting the performance of this contract and causing or likely to cause delay in making the deliveries on the dates required, immediately address a written statement thereof to the Chief of Ordnance for transmission to the Secretary of War with the request that such labor disputes be settled. The Contractor shall furnish such information as the Secretary of War shall require, and shall accept and comply with the provisions and terms of any settlement which the Secretary of War may direct.

Settlement of Doubts and Disputes

(*c*) That any doubts or disputes which may arise under this contract, *except as to matters in respect to which the decision of the Contracting Officer is final*, shall be referred to the Chief of Ordnance for determination. If the decision of the Chief of Ordnance is not acceptable to the Contractor, the matter shall be referred to the Secretary of War, whose decision shall be final.

Contract Not Assignable

(*d*) That the Contractor shall not assign, transfer, or otherwise dispose of this contract, or any part thereof, without the written consent of the Secretary of War, nor shall it assign any moneys due or to become due hereunder.

Notices

(*e*) That any notice addressed to the Contractor at its principal office and either there delivered or deposited in a postpaid wrapper in any postoffice box regularly maintained by the United States, shall be deemed to have been served upon the Contractor. The address of the Contractor may be changed at any time by notice in writing to the Contracting Officer. Nothing herein contained shall preclude service of notices upon the Contractor, (1) where it is a corporation by delivery thereof to any of its officers or directors in person; (2) where it is a firm by delivery thereof to one of the partners; (3) where it is an individual, by delivery thereof to him in person.

Convict Labor

(*f*) That no person or persons shall be employed in the performance of this contract who are undergoing sentences of imprisonment at hard labor which have been imposed by the courts of the several States, Territories, or municipalities having criminal jurisdiction.

Officials Not to Benefit

(*g*) That no Member of or Delegate to Congress or Resident Commissioner is or shall be admitted to any share or part of this contract, or to any benefit that may arise therefrom; but this article shall not apply to this contract so far as it may be within the operation or exception of Section 116 of the Act of Congress approved March 4, 1909 (35 Stats., 1109.)

Definitions

(*h*) That whenever in this contract the words hereinafter enumerated are used, they shall mean what is set opposite them:

Contractor. The party of the first part and its legal representatives, successors and assigns.

Chief of Ordnance. The Chief of Ordnance, the Acting Chief of Ordnance, or any duly authorized representative of either.

Contracting Officer. The officer in whose name this contract is executed, his successor or successors, his or their duly authorized agent or agents, and any one from time to time designated by the Chief of Ordnance to act as Contracting Officer.

Articles. The articles or things to be furnished under this contract, unless some other articles or things are specifically referred to.

IN WITNESS WHEREOF, the parties hereto have caused this contract to be duly executed in quintuplicate by their respective officers, thereunto duly authorized the day and year first above written.

WITNESSES

Contractor.

UNITED STATES OF AMERICA

By: ---

Contracting Officer.

NOTE—Contract provisions shown in italics are offered only as a basis for discussion which will appear in later numbers of ARMY ORDNANCE.

Ordnance Reserve Corps

IT WILL PROBABLY BE OF INTEREST to Reserve Officers to know that the War Department expects to complete by the first of the year a set of regulations governing the commissioning and promotion of officers of the Reserve Corps; the matter of promotion being one of considerable importance especially to those already holding commissions. While no definite information is at hand at this time, it can be stated that the general scheme will be one providing for the promotion of reserve officers on a basis of length of service. In order that the Reserve Corps shall bear a definite relation to the Regular Army, reserve officers will be paired with officers of the regular establishment in grades and carried upward through the various grades along with the regular officers. In other words, a number of reserve officers will be paired with an officer of the regular establishment having the same length of service, and will be promoted to high grades in the reserve as the regular officer is promoted in the regular establishment. This arrangement will present no difficulty in the case of second lieutenants of the reserve. In the higher grades reserve officers now holding commissions as major, lieutenant colonel, etc., will be paired with an officer of the regular establishment in the corresponding grade, and the reserve officers will be given credit for sufficient constructive service to place them opposite the regular officer with whom they are paired.

Reserve officers will then be required to pass an examination for promotion. It will therefore be necessary for reserve officers to keep thoroughly in touch with the particular military matters pertaining to their branch of the service.

It may also be of interest to reserve officers to know that it is not contemplated that reserve officers shall be called to duty for training purposes prior to July 1, 1921.

THE WAR DEPARTMENT is now at work preparing regulations governing the admission into the Army in the grade of second lieutenant of those eligible under the provisions of the Act of June 4, 1920. It is expected that these regulations will be completed in their final form in time for the examination to be held about the middle of February next. Commissions resulting from that examination should then be issued about the middle of April.

Tanks

By

RAYMOND E. CARLSON
Member A. O. A.

[Major Carlson served in France as Assistant American Commissioner on the Anglo-American (Tank) Commission, of which Col. James A. Drain was the American Commissioner. This Commission was created by a treaty between Great Britain and the United States to produce jointly the Anglo-American Mark VIII Tank. The Commission had offices in London and Paris and served as an excellent means of keeping closely in touch with Allied tank developments. For his work on the Commission Major Carlson received special mention from the British Government and the Legion of Honor from the French Government.—ED.]

LUDENDORF LAUGHED AT TANKS, but he was looking at the German *Elfreida* variety, and not the persistent, scrappy man-eating English or French breed. Since tanks were developed by the Allies, Ludendorf was acting in true Germanic form in ridiculing this new arm, the power of which was soon to make him bitterly regret his premature opinion.

The Allies' Opinion of Tanks

In his official dispatch, Field Marshal Sir Douglas Haig stated:

"Since the opening of our offensive on the 8th of August, tanks have been employed in every battle, and the importance of the part played by them in breaking the resistance of the German infantry can scarcely be exaggerated. The whole scheme of the attack of the 8th of August was dependent upon tanks, and ever since that date on numberless occasions the success of our infantry has been powerfully assisted or confirmed by their timely arrival. So great has been the effect produced upon the German infantry by the appearance of British tanks that in more than one instance, when for various reasons real tanks were not available in sufficient numbers, valuable results have been obtained by the use of dummy tanks painted on frames of wood and canvas. It is no disparagement of the courage of our infantry, or of the skill and devotion of our artillery, to say that the achievements of those essential arms would have fallen short of the full measure of success achieved by our armies had it not been for the very gallant and devoted work of the Tank Corps under the command of Maj. Gen. H. J. Elles."

In his foreword to his "Principles of War," Marshal Foch, Commander-in-Chief of the Allied Armies, says:

"The machine gun and barbed-wire entanglements have permitted defenses to be organized with indisputable rapidity. These have endowed the trench, or a natural obstacle, with a strength which has permitted offensive points to be extended over areas quite impracticable until this time. The offensive for the time was powerless. New weapons were sought for and after a formidable artillery had been produced, tanks were invented, *i. e.*, machine gun or guns protected by armor and rendered mobile by petrol, capable over all types of ground to master the enemy's entanglements and his machine guns. It is thus that the industrial power of a nation has alone permitted armies to attack, or that want of this power has reduced them to the defensive."

The tank attack at Cambrai was a complete surprise. No preliminary bombardment was necessary to cut the wire, and the absence of counter-barrage saved at least 10,000 lives. At Ypres, before the zero hour, the casualties were very high; at Cambrai they were nil. The absence of preliminary bombardment left the ground in good condition, so that when the tanks went forward and cleared passages through the wire entanglements and trench systems the supporting infantry followed without difficulty and penetrated to a depth of nearly 10,000 yards. The saving in ammunition and guns, due to the absence of the preliminary artillery preparation, amounted to $25,000,000—and this added to the saving of at least 10,000 human lives.

The Tank Family Tree

It is fortunate for the allied cause that the Tank came from hardy stock. Stern necessity and persistent determination were its creators. It was almost disowned by its rightful parent, the Army, and was developed under the British Admiralty. Had it not been for the foresight, courage and public spiritedness of men like Sir Albert Stern, Sir Eustace d'Eyncourt, Sir William Tritton, Colonel Swinton, Colonel Fuller, Major Wilson and a few others, we might never have had this weapon.

The first designs were completed under Sir Eustace d'Eyncourt, director of naval construction, and the first tank was built at Lincoln, England. Demonstrations of its possibilities before high officials led to its adoption by the general staff and orders were given for its production. Sir Albert Stern was made head of the tank supply branch, later called the Mechanical Warfare Department, British

Ministry of Munitions. The difficulties encountered in the early tank production were innumerable.

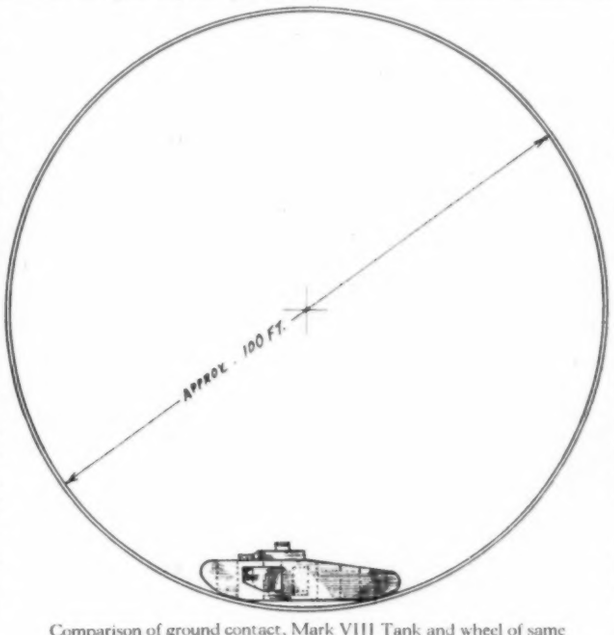
The principle underlying all tank development was covered in the following patent taken out in 1770 by Richard Edgeworth:

"In making portable railways to wheel carriages, so that several pieces of wood are connected to the carriage which it moves in regular succession in such a manner that a sufficient length of railing is constantly at rest for the wheels to roll upon, and that when the wheels have nearly approached the extremity of this part of the railway, their motion shall lay down a fresh length of rail in front, the weight of which shall assist in raising such parts of the rail as the wheels have already passed over, and thus the rails, which are taken up from the rear, are in succession laid down in the front, so as to furnish constantly a railway for the wheels to roll upon."

First photograph of a Tank going into action. British Mark I

The forerunner of the present "whippet" type is found in a tractor patented in 1888 in the United States and known as the "Batter" tractor. In type of track and contour, and in method of drive, except that steam was used instead of gas-engine power, this tractor very closely resembles the present-day fighting machine.

Numerous attempts to produce land battleships are on record. All of the vehicles were of a wheeled type, and during the past war various proposals were made to employ large wheels on tanks so that they could easily roll over such obstacles as trenches, entanglements, etc. The illustration shows the great size of wheel which would be required to give a contact with the ground equal to the Mark VIII Tank. The impracticability of this large wheel is obvious from considerations of weight, ground pressure, steering power and target which it presents. The caterpillar form of track on the Mark VIII Tank gives a ground contact greater than a wheel 100 feet in diameter.



Comparison of ground contact, Mark VIII Tank and wheel of same obstacle-surmounting power

The possibilities of the caterpillar track for tank use were shown during maneuvers and tests of American-built caterpillar tractors. The use of the all-round caterpillar tracks gave the tank its uncanny trench crossing ability.

It is difficult to say who invented the tank. Opinions are widely divergent on this point, as was brought out in the hearings before the British committee appointed to make awards.

The awards, as finally made, were divided among several men, among them being Winston Churchill, Sir William Tritton and Major Wilson. Two very interesting and instructive books have been published on tanks and set forth in detail the development and use of tanks. The first is "Tanks," by Sir Albert Stern, *K. B. E.*, who gives an interesting account of the development and production, and the second book is "Tanks in the Great War," by Lt. Col. J. F. C. Fuller, *D. S. O.*, Chief of Staff, British Tank Corps, who in addition to covering the development dwells more particularly upon the employment of tanks during the war.

The first tanks were built with the utmost secrecy. Not even the workmen in the shops knew the real purpose of the machine they were building. This was accomplished by spreading broadcast the information that the machines were to be used for carrying water in Egypt and the name "water-carrier" actually appeared on all correspondence and records. For various reasons, among them the tendency to abbreviate, this name was gradually changed to tank, and has clung to the machines ever since.

Anglo-American Co-operation

When America entered the war our knowledge of tanks was practically nil. But the American command in France saw great possibilities in tanks and set out to learn about them. What they learned and did resulted in a tank-building program of over four thousand light tanks, to be constructed in the United States, and a joint program with England for building heavy tanks. Additional numbers and types of tanks developed later. An Anglo-American tank commission was formed with Sir Albert Stern as British Commissioner and Lieut. Col. James A. Drain as American Commissioner.

The pressing question was, How to produce the most tanks in the shortest time without interfering with other allied and American projects. How could these great machines of war be transported across to France when tonnage was so vital? How could we secure the necessary armor plate, which required years of experience and trial to perfect? World's resources of raw material and skilled labor were being exhausted. How could we utilize them most efficiently for production of tanks?

Co-operation with England guaranteed the most efficient tank from a fighting standpoint; co-ordination of manufacturing and transport facilities, making armor plate in England, making machined parts in America, where we had great capacity available. Building a factory in France for the assembly of components, shipping components

British Mark IV Tank going into action

"knocked-down" from England and America to this factory and saving ship space—all this was in line with the Ordnance policy of co-operating to the fullest degree with our Allies in shipping components of guns, shells, machinery and other munitions in lieu of producing at home a lesser number of completed units.

All this was done. A capacity of 300 to 500 tanks per month was arranged for and a large number of British components were actually at the assembly plant in France when the armistice was signed.

Evolution of Types

The illustrations show the general characteristics of the principal types used during the world war and space will permit of only a somewhat sketchy description. The first British tank, the Mark I, utilized as many standard farm tractor parts as possible, the engine and transmission being taken from the Foster-Daimler tractor and adapted to the tank by the addition of gears and chain drive to the tank driving sprockets. The Marks II, III and IV were variants of the Mark I, the Mark IV having 12-mm. thickness of armor plate instead of 10-mm. as on the Mark I.

French Renault 2-man Tank

The Mark V tank marked an important step forward —one-man control and epicyclic gearing. In the Mark IV tank the average speed was about 1 mile per hour, while the Mark V gave an average speed of 2½ to 3 miles per hour. Life of the wearing parts was also increased so that whereas the Mark IV tracks were only safe for about 25 to 30 miles, the Mark V tracks could go well over 100 without failure.

By this time the Germans had begun to widen their trenches in an effort to keep tanks from breaking through, and this required larger tanks. After unsatisfactory attempts had been made to lengthen Mark IV tanks by the addition of tails or "tadpoles" the Mark V one-star was brought out, which was a Mark V tank with a 6-foot gusset in its middle, bringing its total length up to 32 feet.

Anglo-American Mark VIII

The Hindenburg Line was holding up the show and a heavier and better tank was needed for the break through. When the Anglo-American Treaty was signed and the design of the new joint tank begun, Allied tank authorities were unanimously of the opinion that this tank must cross the Hindenburg Line. Judging from its performance in actual tests it would have done it hands down. This tank weighs 40 tons, is 34 feet long, carries 11 men, and is armed with two 6-pounder cannon and 5 machine guns.

Numerous other types were designed and built, and in addition to the Mark IV and Mark V, the Medium Mark A or "whippet" deserves mention. This whippet was lighter and faster than previous types and rendered remarkable service. The experiences of the crew of one whippet, *The Musical Box*, read like tales of the strangest fiction. In one place they ran across 30 men, gunners of a German battery, and "accounted" for the lot. In another they broke up a transport train behind the lines, and at another place "accounted" for 60 Germans. This only illustrates the possibilities of the "steel cavalry."

French Tanks

Tanks were being developed in France about the same time. The French Tanks were originally designed for purposes of carrying up infantry, the principle of employment being similar to the famous "Horse of Troy," used by the Greeks in the capture of Troy, as told in the Iliad.

The use of English tanks hastened the French development along the lines of producing a real weapon of offense. These tanks were produced in the plants of Schneider & Cie., and in the St. Chamond factories. The Schneider and St. Chamond tanks were deficient in trench crossing ability, due to the great overhang of the body beyond the tracks. The French baby tank was designed and produced in the plants of Louis Renault, constructor.

The guiding spirit in the design and production of French tanks was Colonel Aubertin, and great credit is due to this able officer and his associates, in making possible the equipment of our own tank corps with French light tanks.

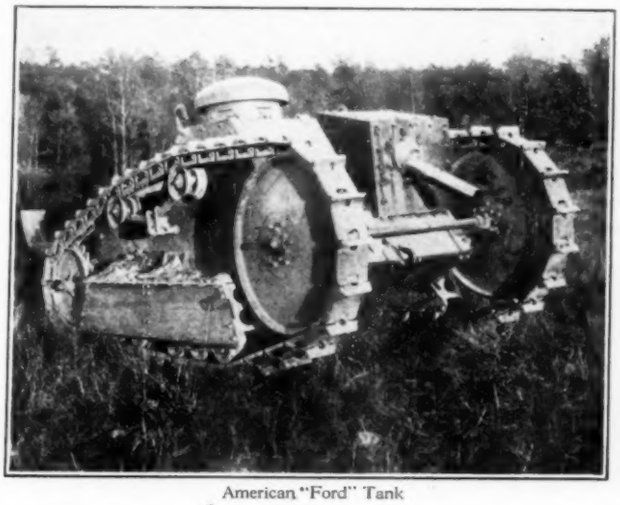
Larger experimental tanks had also been built, but never placed in production, as the French armies were depending on the Anglo-American Mark VIII tank to supply their needs for heavy tanks.

Italian Tanks

The Fiat Company had built an experimental tank, but it was never placed in production and arrangements had been made to use and produce the French Renault type.

American Tanks

The American Tank program consisted of the French Renault type modified only to permit American production, the Anglo-American Mark VIII tank, and in addition an American Mark VIII program, and the Ford 3-ton tank. Although only a few experimental Ford Tanks were built, the production of 15,000 was authorized and would have been turned out. This tank was first and foremost a production job, utilizing a great many standard Ford car parts. Numerous other experimental types were also built, but never produced in quantities.



American "Ford" Tank

German Tanks

Germany made a feeble and tardy effort to get tanks, and was only able to turn out the *Elfreida* type whose usefulness was about nil, judging by the fact that it moved about sluggishly and mired down completely when rough ground was encountered.

Trend of Development

The efficieney of tanks, like other weapons, is only relative, depending upon the effectiveness of counter measures. Based on the past war's experience strenuous efforts have been and are being made to make tanks more reliable, give them greater mobility, better vision, and develop better means of communication. Efforts are being concentrated along the line of producing one type of tank—a tank that can do everything the large and small tanks did, and do it better. Considerable success is reported, and we now hear of tanks capable of speeds up to 20 miles per hour and able to run long distances on one fill of fuel.

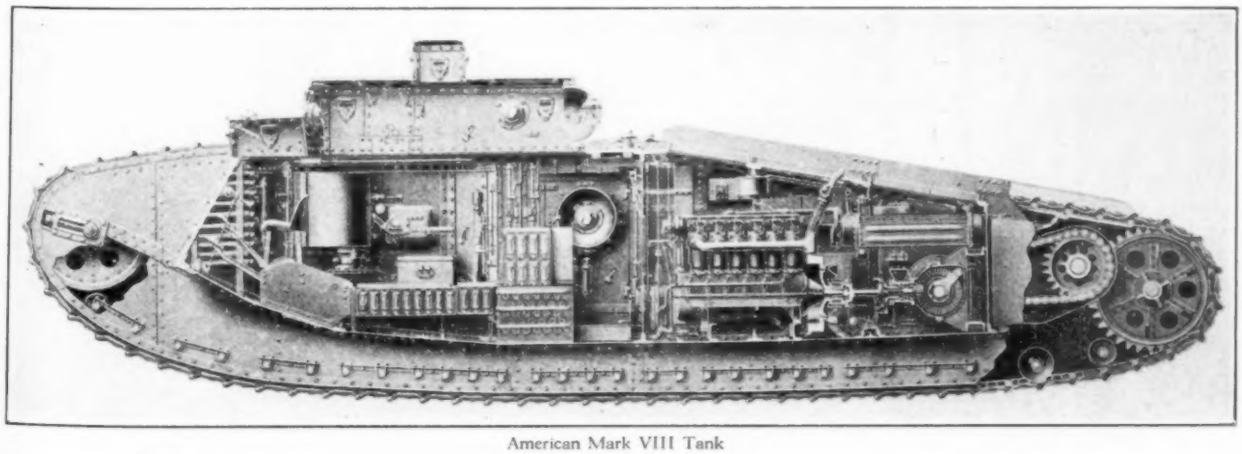
Future Tanks

This past war has proven beyond the peradventure of a doubt the wondrous possibilities of mechanical warfare. Mechanical power against man power is an uneven match. Whether or not we profit from this war's experience depends upon ourselves. A broad and comprehensive military policy for the use of tanks must constantly be preached. Design of mechanically better tanks must be stimulated, and this means that Congress must provide money both for experimental designs and the production of tanks for the equipment of service units.

Why was Germany successful in the early days of the war? Because of the nearer approach to perfection of her weapons. There is reason to believe that mechanics will still further revolutionize the science of warfare. Millions of men in the field, men to train, clothe, feed, transport, and care for, may soon be a memory of yesterday. In their place will come new machines of war mechanically operated.

Future tanks must be universal in their use. They must be able to pass through land and water obstacles with impunity. They must be mobile, capable of high speeds to enable quick concentration and stunning blows to be struck the enemy. Better eyes and ears must be given them so that the tank commander can, if he desires, talk to his tanks from his armored airplane and send messages to the rear. Gas protection will be necessary. Means for screening their movements by smoke or other devices must be available. They will probably rely on radio direction or improved compasses to get their bearings. It is not beyond the pale of conception to draw a mental picture of a noiseless, speedy, amphibious tank, protected against gas, airplanes and mines, able to run at speeds up to 25 miles per hour, with fuel and food supplies to last for days, and able to talk to airplanes above and tank headquarters in the rear. With thousands of such machines the result would be inevitable.

Above all, these future tanks must be designed for quantity production. This war has shown that not only the army but the people of the whole country make war. America is essentially an industrial nation and a tremendous factor for preparedness would be advanced designs of tanks capable of being produced by the thousands. The success of future wars will not be measured in terms of men, but in terms of mechanical improvements over men.



American Mark VIII Tank

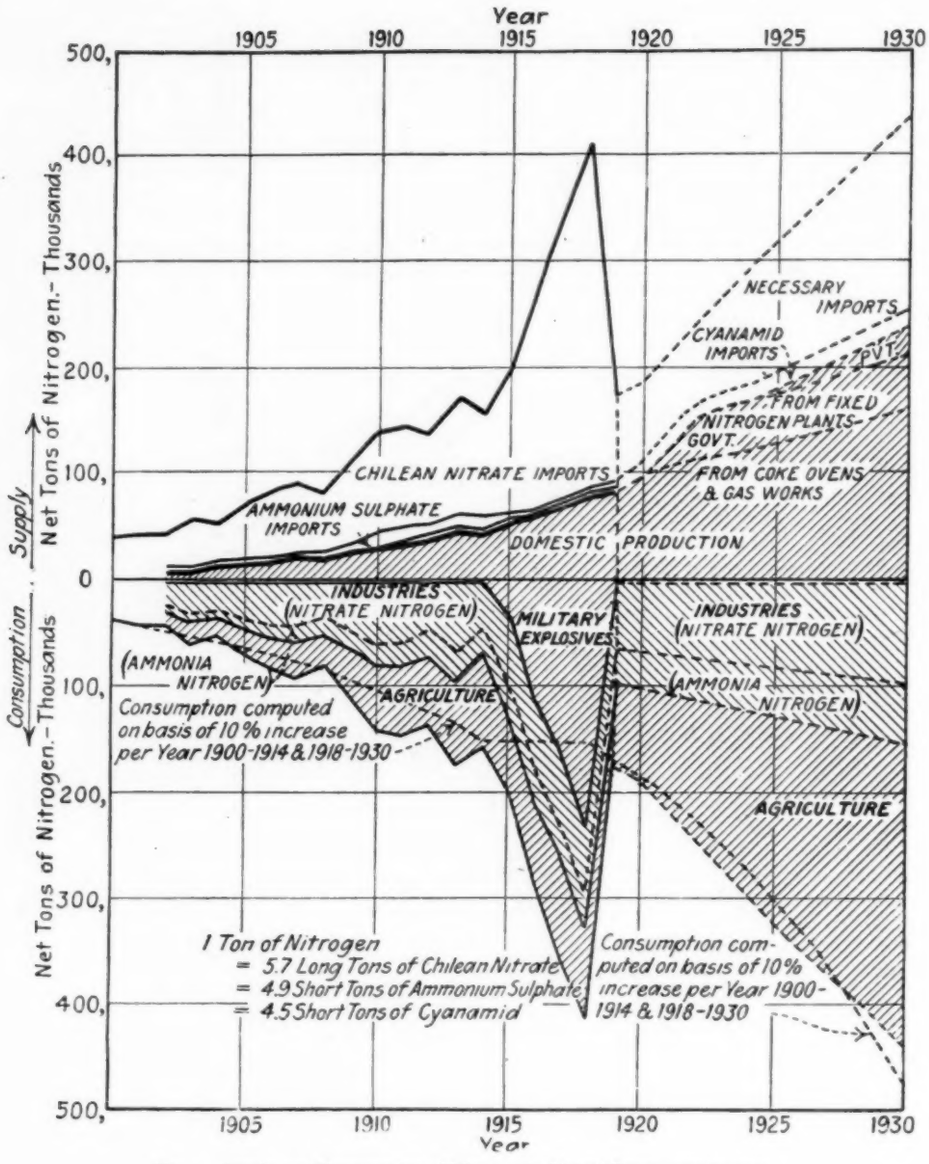


Fig. 1. Supply and Consumption of Nitrogen in United States, 1900 to 1930

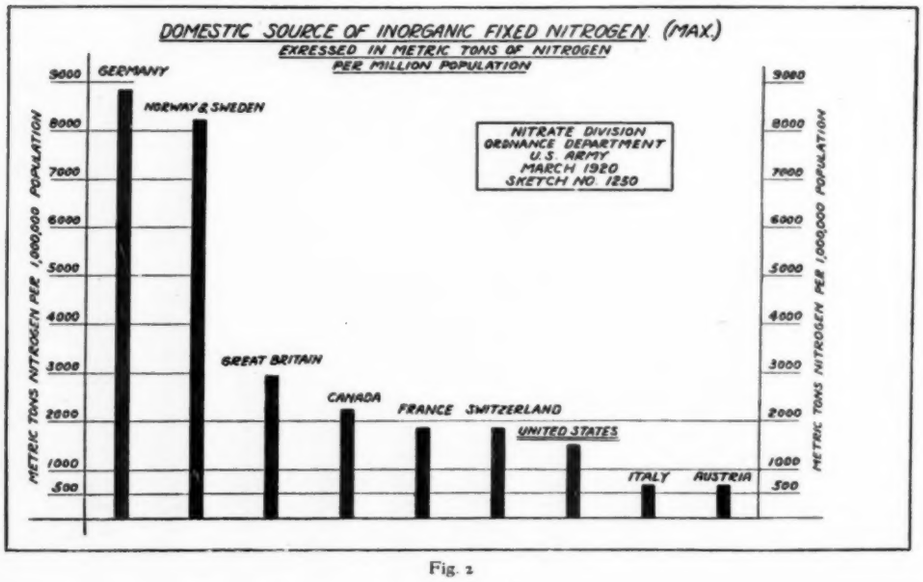


Fig. 2

Nitrogen

Its Vital Importance in National Defense

By

D. P. GAILLARD

Member A. O. A.

[Maj. D. P. Gaillard, author of the following article, is Executive and Technical Assistant to the Chief of the Nitrate Division, Office of the Chief of Ordnance, U. S. Army, and has served in that division since shortly after its organization in July, 1917.—Ed.]

THAT INORGANIC NITROGEN IS NECESSARY in the manufacture of practically all military explosives and therefore is an absolute essential for any war program is now rather generally appreciated; it is perhaps not yet so generally realized that the other uses of nitrogen, in artificial refrigeration, in the chemical industries and perhaps most important of all in commercial fertilizers also make it a war essential.

And for this war essential we are now, and in the past have been dependent upon imported nitrogen for by far the largest part of our supply. Figures show that in the past twenty years more than three-fourths of the nitrogen consumed in this country has been imported, and during the war this proportion increased to more than four-fifths. Even now, with all the increase in the domestic production that the war brought forth, more than half of our peacetime supply of nitrogen must be imported and conditions, if allowed to take their natural course, promise no improvement in the future.

It may seem that there has been an undue amount of attention given to this problem of nitrogen supply, but as nitrogen is so essential in time of war and as we are so largely dependent upon imports for this nitrogen, it will be admitted that the problem is a serious one; and the question as to what we can do now in the way of reasonable nitrogen preparedness is one well worth careful consideration.

Consumption and Supply of Nitrogen

Before discussing this it may be well, however, to see just how the nitrogen situation stands now as regards consumption and supply, and just how this situation has developed during the past few years.

The consumption of nitrogen has been increasing so rapidly, not only in this country but throughout the world, that in order to study it intelligently it is not satisfactory to consider merely the present situation and conditions as they are now, but the trend of developments from year to year up to the present must also be considered. In order to do this conveniently and to forecast conditions in the next decade as well as possible, the attached chart (Fig. 1) has been prepared.

On this chart for each year the consumption of nitrogen is indicated by negative ordinates and the supply of nitrogen by positive ordinates. It will be noted that the consumption in each year has been assumed equal to the supply, an assumption, of course, not entirely correct, but sufficiently so when studying the trend of conditions from year to year.

Increase in Consumption. This chart shows how our total consumption of nitrogen from 1900 to 1914 increased at a somewhat greater rate than 10 per cent per year. The British Nitrogen Products Committee in their report state that the world consumption of nitrogen doubles every ten years. This even more rapid increase in the United States is due not only to the growth of the newly-developed nitrogen consuming industries which include besides artificial refrigeration, the manufacture of industrial explosives, artificial leather, photographic films, artificial silk, dyestuffs, etc., but also to the rapidly increasing use of chemical fertilizer because of the gradual exhaustion of the original fertility of the soil, the increased value of the farm lands and the increased cost of farm labor and to the fact that the organic nitrogen carrying materials are being properly diverted more and more for foodstuffs.

Military Explosives. It will also be seen on this chart how the requirements for nitrogen for military explosives first assumed importance in 1915, when we began manufacturing munitions for the Allies; increased in 1916 and still again in 1917 and 1918 until in the latter year it is estimated some 230,000 tons of nitrogen equivalent to 1,300,000 long tons of Chilean nitrate, were used to manufacture military explosives and to partially build up a reserve stock of nitrate which was to be sufficient in case our nitrogen supply should be interrupted to supply our needs until additional nitrogen fixation plants could be built. This quantity of nitrogen was considerably greater than our entire consumption of inorganic nitrogen for all purposes in any year before the war and necessitated our importing from Chile almost three times as much nitrogen as we had ever imported before. In June, 1918, there were 105 steamers and 23 sailing vessels, aggregating some 700,000 tons in the "Nitrate fleet," and this at a time when we needed every ship for forwarding troops and supplies to France. This greatly increased demand for nitrogen was, of course, accompanied by an increase in price, but in spite of this it will be noted that the consumption of nitrogen in the various industries and for fertilizer not only did not decrease but slightly increased.

Increase in Domestic Supply. The chart will also show how the increase of consumption before the war was accompanied by a very considerable increase in the nitrogen recovered by the by-product coke ovens. In spite, however, of this rapid development, consumption increased so fast that the proportion of nitrogen supply from this source only increased from about one-sixth in 1902 to about one-fourth in 1914.

During the war the Ordnance Department, by special contracts, encouraged the building of by-product coke ovens principally to obtain the toluol, but also for the

nitrogen recovered in the form of sulphate of ammonia. As a result the by-product coke oven capacity of the country, when the last of these coke ovens come into operation this year, will have increased by more than 60 per cent since the war. In spite of this increase, however, the nitrogen needs of the country have by no means been met and the imports of Chilean nitrate this year have been very large. In fact, it is believed that the total figures for 1920 will be exceeded only by those for 1917 and 1918. These tremendous imports mean that this year the by-product coke ovens and gas works, the only domestic sources of nitrogen other than the idle Government nitrate plants, will supply only about one-third of the nitrogen consumed in the country.

It would be very desirable if this source of supply could be still further largely increased and all the coke could be produced in by-product coke ovens. Owing, however, to the fluctuating character of the demand from year to year for coke in the iron industry, it is doubtful if in the next few years more than some three-fourths of the coke will be produced in by-product ovens. And as over half of the coke is now manufactured in that way and as the total requirements for coke are limited by the demand of the iron industry in the nature of things the supply from this source cannot increase at so rapid a rate in the future as in the past.

Imports. It will be noticed that although before the war some nitrogen was imported as sulphate of ammonia, largely from England and as cyanamid from Canada, these two materials at their maximum constituted no more than one-fifth of the total imports, Chile supplying the remainder in the form of nitrate of soda.

Forecast of Future. A detailed study has been made of the several peace-time nitrogen consuming industries, and as a result of these studies future conditions have been forecast with the results shown on the chart. That these assumptions are not unreasonable is indicated by the fact that the rate of growth in the consumption of nitrogen thus forecast for the next ten years is not so great as in the fifteen years prior to the war.

Deficiency in Domestic Supply. The net result of this study is to indicate beyond any reasonable doubt that in the next decade, if the Government nitrate plants are kept idle, as they are at present, less than half of the nitrogen needed in this country in time of peace will be produced here and that conditions instead of becoming better, will slowly become worse. And this takes into consideration only the peace-time consumption. For if in the next decade this country should become involved in another war taxing our resources to anything like the extent that they were during the world war, we would be only about 25 per cent self-sustaining in our nitrogen supply. Of course, during the world war we were supplying and preparing to supply to a not inconsiderable extent the ammunition requirements of our Allies, as well as our own, but in a future war with only our own requirements to take care of, it is probable that the rate of fire would be increased over that in the world war enough to make our total requirements as great as they were at that time.

What We Can Do Now

With this situation before us, the question naturally arises as to what can be done at this time to insure this country the maximum nitrogen preparedness?

Nitrogen Reserve. The first and most obvious thing is that a nitrogen reserve should be maintained and the Ordnance Department now has such a nitrogen reserve in the shape of loaded ammunition, bulk explosives and 300,000 long tons of sodium nitrate. This reserve, it is believed, would be sufficient to provide for our military nitrogen requirements in case of interruption of our nitrate supply until such time as additional nitrogen fixation plants could be gotten into production.

Operation of Government Nitrate Plants. The two Government nitrate plants with a nitrogen capacity about half that of the by-product coke ovens, are now being maintained in a standby condition although certain construction work is now in progress in order to complete these plants and make them available for turning out a supply of nitrogen should an emergency arise. This is all that the War Department can do under its present authority.

It is very desirable, however, that the operation of these plants be authorized. For not only will the product be more quickly available for military use if the plants are operating, but there will be available a going organization and a focus of knowledge which will be of the utmost importance in case it is necessary to duplicate these plants in an emergency. Further, the plants themselves will be up-to-date and abreast of the art, and their equipment will be in much better shape than if they are kept idle. Incidentally, the nitrogen produced in time of peace will be available for and can easily be absorbed by the industries and agriculture of this country.

To insure this operation War Department representatives have endeavored to interest private industry in purchasing or leasing these plants under proper guarantees, but without success. This is probably due to the fact that although there is no doubt that the products of the plants can be sold for more than the operating expenses, the margin is apparently not enough to attract at this time the capital required, when capital is being so eagerly sought for more firmly established industries. In fact, the present high cost of capital coupled with the high cost of construction render it very improbable that any privately-owned nitrogen fixation plants will be built and get into production in this country in the next few years. The War Department has, therefore, been forced to recommend to Congress the operation of the Government plants along business lines by a Government-owned corporation, very much as the Panama Railroad and its steamship line have been operated for the last fifteen years. A bill providing for this is now pending before both houses of Congress, having been favorably reported to the Senate by the Committee on Agriculture and still being before the House Military Affairs Committee.

Development of Art of Nitrogen Fixation. Another thing that can be done to help the present situation is to study and develop the art of nitrogen fixation in order that this country may be thoroughly up-to-date. The Ordnance Department already has the authority to do this under the "Nitrate Supply" section of the National Defense Act of 1916, and is maintaining in Washington a well-equipped fixed nitrogen research laboratory with a staff of eminent chemists and physicists and results of very considerable importance are now being obtained, primarily for application in the Government nitrate plants, but available for the most part for the general furtherance of the art in this country.

Electric Power Supply. The matter of electric power supply is still another factor in the situation, as two of the three present commercial nitrogen fixation processes, the electric arc and the calcium cyanamide process, require relatively large amounts of electric power. Our experience during the war demonstrated that a nitrogen fixation plant could be built much more quickly than its electrical power supply could be developed. Moreover, this question of an

ample supply of electric power is a very important one not only for nitrogen fixation but for the munitions program generally.

In fact, its importance and scarcity during the war was such that a special section of the War Industries Board had to ration it out to the several war industries. In some cases certain localities were even absolutely ruled out of additional munitions work because of their shortage in power supply. This entire question of power supply and particularly the question of unification and co-ordination of power supply is now being actively considered. The Geological Survey is making a study of a super-power line extending through and tying together the power systems of the North Atlantic coast states. In addition several of the larger power systems are themselves studying carefully the possibilities and advantages of interconnection as a means of increasing their outputs without proportionately increasing their power producing facilities. Further, the water power act is at last an accomplished fact, and it is to be hoped that several large water power projects will be developed as soon as prices become more stabilized.

In the meantime the War Department itself is not unmindful of the necessity both from a military and an industrial point of view of an augmented power supply and is now constructing, through the Engineer Department of the Army, at Muscle Shoals, Alabama, the Wilson Dam, with an ultimate installed capacity of 375,000 horsepower.

If an adequate reserve stock of nitrate is maintained, if the operation of the Government nitrate plants be authorized, if the art of nitrogen fixation is actively studied and developed, and if the electric power resources of the country are co-ordinated and developed to the limit we will probably have done as much for nitrogen preparedness as it is reasonable to expect in time of peace.

The Situation When War Comes

Restriction of Consumption. Should this country become involved in another war, even if all these measures looking toward nitrogen preparedness have been effected, the problem will not be entirely simple. The first efforts to meet the situation would probably be an attempt to restrict the non-essential uses of nitrogen. Study shows, however, that very few of the uses are non-essential. Certainly refrigeration and fertilizers are even more necessary in war than in peace for insuring an adequate supply of foodstuffs as during a major war we have a restricted labor supply on the farms coupled with a demand for maximum production, and the only way to meet this situation is to increase the production per man by the use of fertilizer and preserve what we get by refrigeration.

Adapting Commercial Plants. The next effort undoubtedly would be to adapt the existing nitrogen producing plants, that is, the by-product coke ovens and the nitrate plants to produce nitrogen in the exact form needed for the manufacture of explosives. Fortunately this is a matter involving few technical difficulties, and the time required for this would probably be no more than that needed to get into operation the explosives plants themselves.

Increasing Imports. Coincident with these efforts assuming that we retained control of the seas, imports would be increased to the maximum extent. The question of shipping, which was so critical during the last war, would not be such a factor now, owing to the greatly increased American tonnage available, but it must be remembered that imports are absolutely dependent upon our maintaining uninterrupted a long sea line of communications.

Multiplication of Nitrate Plants. In any event, it would almost certainly be necessary to duplicate the existing nitrate plants, and experience shows that this could not be done in very much less than a year and then only by expanding a going organization familiar with the manufacturing process and utilizing supplies of electric power previously developed.

Nitrogen Situation in Foreign Countries

So much for our own situation. It may be interesting, however, to review briefly the nitrogen situation in the leading foreign countries and see how we compare with them.

Germany. Germany besides having a by-product coke oven capacity somewhat greater than ours, possesses nitrogen fixation plants of a total capacity more than eight times that of our Government nitrate plants. And as a part of this capacity has been built since the war and as she was completely self-sustaining in nitrogen during the war when her resources were strained to the utmost, she would certainly seem to be adequately prepared for the future.

Great Britain. Great Britain, too, has about the same by-product coke oven capacity as we have, and in addition is now constructing a nitrogen fixation plant about two-thirds the capacity of ours and is planning to increase its capacity three-fold as soon as the demand warrants it. Moreover, it must be remembered that Great Britain has a larger Navy than we have and would seem to be in much less danger than we are of having her nitrate supply from Chile interrupted in event of war.

Other Countries. Norway and Sweden with their extremely cheap waterpower are well provided with fixation plants, which also are to be found in France, Switzerland, Italy, Holland, Austria, Japan and Canada. Besides in practically all of these countries the by-product coke oven industry is established, though in some, of course, it is of very small proportions.

Our Relative Position. The real standard of comparison, however, and the relative measure of nitrogen preparedness is the ratio of the total domestic nitrogen producing capacity to the population of the country. The attached chart (Fig. 2) shows the relative position in this respect of the different foreign countries and of the United States, and shows graphically how far behind the leaders we are.

Remedy for Present Situation

This completes the review of our nitrogen situation, and it must be admitted that the situation is not very satisfactory from the point of view of our military security. The Department believes, however, that if it can present the situation clearly to those who make our laws and lay down our military policy, it will be appreciated by them, and hopes that coupled with a liberal policy as regards electric power development, authority may be obtained to operate the existing nitrate plants and so help to remedy our present state of nitrogen unpreparedness.

While fixed nitrogen in one form or another is indispensable to a nation at war, it is equally important to the nation at peace; and in the present state of civilization, it is true that no nation can become or remain great either in peace or war that is not provided with an ample supply thereof. *Burns.*

Air Bombing of Industrial Plants

By

WILLIAM A. BORDEN

Member A. O. A.

[The outstanding lesson of the World War was the CONTROLLING INFLUENCE of MUNITION POWER—in contradistinction to man power. Accordingly, it is highly probable that the strategy of future wars will turn largely on attempts to destroy or diminish munition power by attacks upon industrial centers. Of the methods available for this purpose, the most logical will undoubtedly appear to be the dropping from aeroplanes of huge bombs containing a ton or more of high explosives and capable of effecting complete effacement of the factories attacked.

In picturing the possibilities of this new menace, Colonel Borden, at present Chief of the Aircraft Armament Division, Office of the Chief of Ordnance, has brought up a question which should engage the attention of every American manufacturer. The future may see some purely defensive methods for meeting this menace developed to a certain degree of practicability, but until that day dawns, our best protection will be the developing of superior methods for conducting OFFENSIVE operations of this kind. By being able to carry the fight into the enemy's country with overwhelming superiority, we can thereby dictate the advisability of his leaving our own industrial centers inviolate for fear of reprisal.—ED.]

FRANCE, ENGLAND AND OTHER EUROPEAN COUNTRIES were, during the World War, subjected to numerous aerial attacks in which the main munitions used were bombs, and although bombing was not highly developed even when hostilities ceased, considerable material damage resulted from these air raids. The morale of the people in raided localities was lowered and the production of munitions and other necessary items of supply was interfered with and delayed.

Although, of the number of bombs dropped, only a very small percentage hit their target, yet the destruction which it was possible to effect by bombing operations was appreciated, and elaborate systems of defense were instituted, particularly in areas where important manufacturing activities were under way. Anti-aircraft equipment, searchlights, aviation patrols, and a system of warning signals were employed. in the defense of these localities. The important machines in manufacturing plants were protected by armor plate shields, other parts of the plants were protected by earthen embankments, and traverses to limit the effect of flying fragments, while various systems of camouflage were employed in screening the building. However, in spite of the extensive means of defense, bombing raids were becoming increasingly effective at the close of the war.

Detonation of American 600-pound Demolition Bomb

Bombs in general were developed during the war from the crudest devices imaginable to the present ones which are even yet far from being satisfactory. The first bombs were made from converted artillery ammunition, and were more or less makeshift affairs of very little value. Today, they are no longer mere adaptations, but specialized devices, designed for a specific purpose. Bombs weighing from a few ounces up to 1100 and 2200 pounds have actually been produced, and the development of others which will weigh even more is contemplated. There appears to be no limit to the size of bombs, provided aircraft can be made large enough to carry and drop them.

Briefly, the general types of bombs are Demolition, Fragmentation and Chemical. There are other types, such as Anti-submarine and Armor Piercing, which are used for special operations, but only the general types hold significant interest for the manufacturer, as these will mainly be used against his plants.

Demolition Bombs are those which destroy through the blast produced by the detonation. These were used during the war, and probably will be used in the future to the greatest extent in destroying material targets. They are generally large and are so designed that as much explosive as possible is carried for a given weight of bomb, the object being to obtain the maximum blast effect from the detonation. They range in weight from 100 pounds to 1,000 pounds and over. The 100-pound bomb will destroy small railroad stations, small storehouses and powder magazines,but when manufacturing plants, permanent storehouses, railroad terminals or similar large and substantial targets are attacked larger bombs are employed.

The damage produced by the recent explosion in Wall Street is practically nothing compared to what may be expected from our Demolition Bombs of the larger sizes. The object of Demolition Bombs is to demolish, and a 1,000-lb. bomb hitting almost any of the present factory buildings would completely wreck it. It must be understood that these bombs have fuses which give a delay action, so that the bomb does not function on the roof of a structure but penetrates to the interior before detonating, thus allowing the full force of the detonation to be effective in all directions, literally rending the buildings apart.

Under certain circumstances it is desirable that these bombs function instantaneously, as for example, when a direct hit is made on a street. In such a case to obtain the maximum amount of material damage it is essential that the lateral force of the detonation and lateral dispersion of fragments act without obstruction against the walls of

the adjacent buildings. To accomplish this the bomb must be equipped with a fuse which will function instantaneously upon impact with a hard surface street, but will give delay action when the bomb strikes a less resistant structure, such as a building. This type of fuse is necessary, for the reason that a bomb equipped with a fuse functioning with delay action only, though it will produce a very large crater when it strikes a street, will cause little material damage to adjacent buildings, as most of the dispersed fragments will be caught in the sides of the crater and the force of the detonation mainly directed upward. When very large bombs are dropped from very low altitudes, a delay of fifteen seconds or more is necessary to enable the airplane to escape the force of the detonation and the flying fragments.

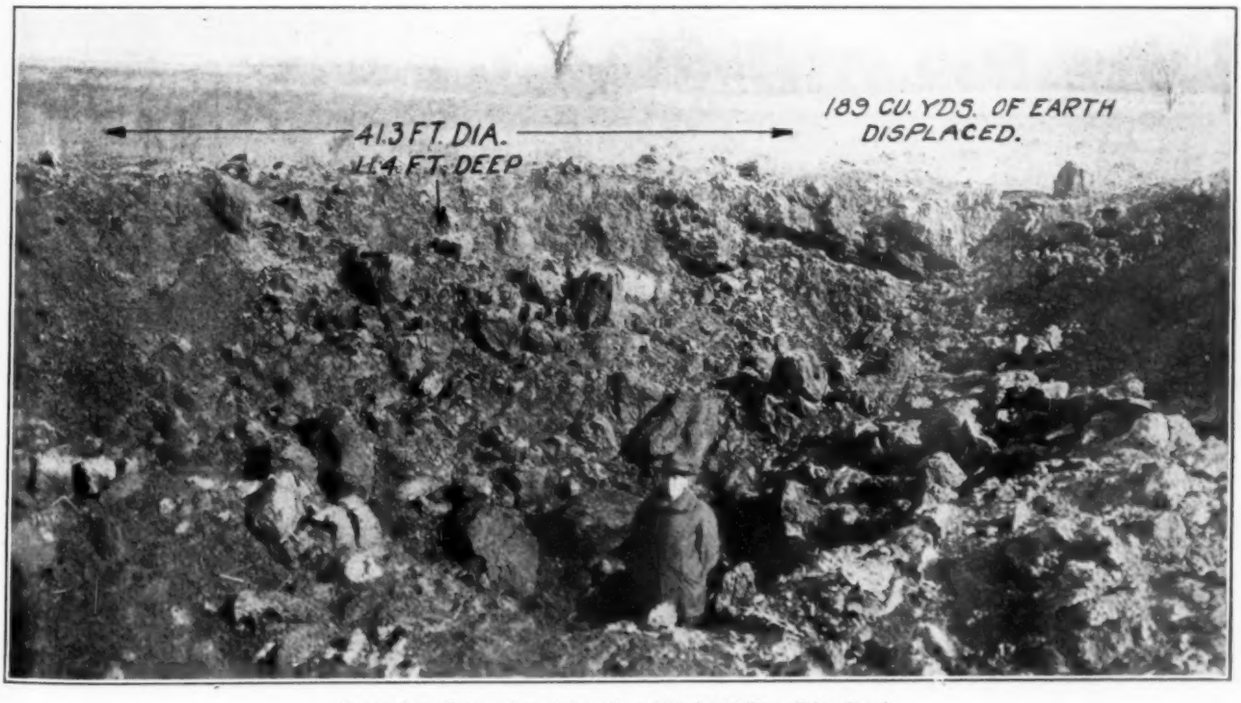
Destruction of factory by a single bomb

While Fragmentation Bombs are primarily designed to wound or kill and are particularly effective against massed bodies of troops, troops in billets, troops in column, convoys, and similar targets, they may also be used to supplement Demolition Bombs in attacks upon manufacturing plants. Though the trend in development of Demolition Bombs is toward very large sizes this is not the case in the development of Fragmentation Bombs. Here the size is limited by the effect required, which is the production of the maximum number of effective fragments over the greatest possible area.

During the war the dropping of hand grenades and other small bombs such as steel darts was tried, but it appeared that for the most effective results a bomb heavier than the hand grenade was required. After considerable trial the size of Fragmentation Bombs has been fairly well established at approximately 25 pounds. The functioning of the Fragmentation Bomb is somewhat different from that of the Demolition Bomb, in that the fuse of the bomb is designed to cause the bomb to function always above or at the surface of the ground. This prevents the formation of a crater, and, therefore, allows a wider and more uniform distribution of fragments.

The detonation of our present Fragmentation Bomb produces approximately 800 fragments. All of these, however, are not effective as some are lost by being driven in the ground near the point of impact, while others are projected in the air over the heads of possible troops and their energy dissipated in flight. Tests are conducted to ascertain the number of casualties which would result from the detonation of a bomb dropped among troops, and a study of such tests has shown that the bomb we are using will produce approximately 34 casualties in a field 312 feet wide by 343 feet long in which 140 men are standing in 20 rows with 7 men in each row.

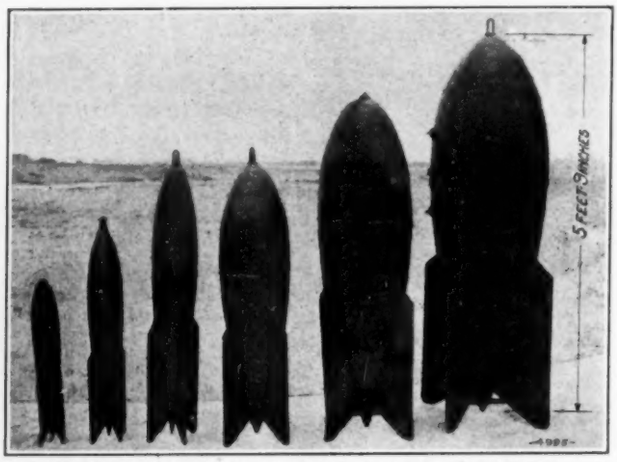
There are but two types of Chemical Bombs which are likely to be used against manufacturing plants, the Incen-



Crater from Detonation of American 1100-pound Demolition Bomb

diary Bomb and the Gas Bomb. The Smoke Bomb, which is used for concealment in various ways in different operations has little if any destructive value.

Incendiary Bombs are those which destroy through the production of a conflagration. This type of bomb was not highly developed during the war. It was used in several different sizes, and its construction varied. The targets against which this type of bomb is used are sufficiently different to have made it impossible to get satisfactory results with a single design of bomb. This has brought about the development of two general classes of Incendiary Bombs, one the intensive type, the other the scatter type. The intensive type of bomb produces a very hot and lasting flame at the point of impact. The scatter type of bomb is,



American demolition bombs developed during the war. 25-pound, 50-pound, 100-pound, 300-pound, 600-pound and 1100-pound

as its name implies, a bomb which scatters its incendiary contents over a relatively large area, producing points of flame wherever they strike. The scattering effect is also obtained by dropping hundreds of small bombs of this same type. The intensive type is used in destroying targets such as manufacturing plants and storehouses where an intense flame of rather long duration is required to start a conflagration. For the successful attack of such targets the bomb must usually penetrate before functioning.

Woods, grain fields and light wooden structures, which are very inflammable, are easy to ignite and should be ignited over a considerable area in order to make it difficult to extinguish the fire. Therefore, against these targets, the scatter type of bomb is used. During the recent war the smallest effective bomb used was a type of scatter incendiary bomb which weighed only a few ounces. In the attack upon a munition plant it is very probable that Demolition Bombs would be dropped, followed by Incendiary Bombs, the object being to tear open the buildings with the Demolition Bombs and burn them up with the Incendiaries. The use of Incendiary Bombs produces a decided lowering of morale in the areas bombed. Some Incendiary Bombs ignite shortly after being released from the airplane and descend in flames, giving a meteor effect which is terrifying in the extreme.

25-pound fragmentation bomb for attack on personnel

Up to the present time gas bombs have not been used in warfare, and no one can state positively that they will be employed in the future, but with the experiences of the past war fresh in our minds it is not very hard to conceive

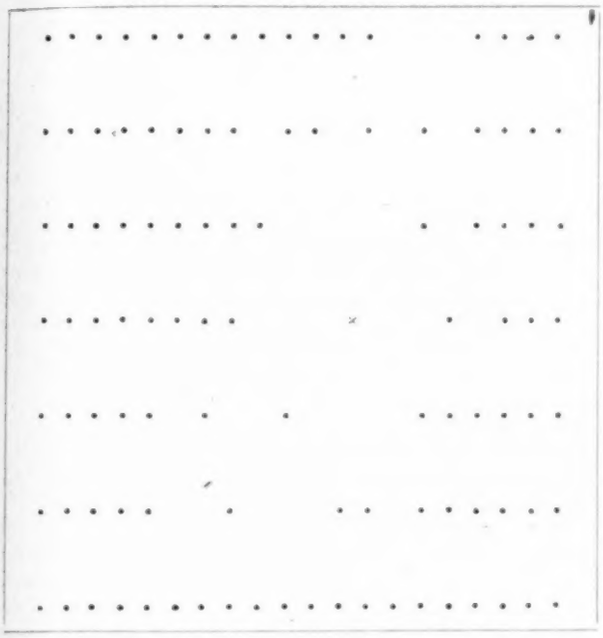
Demolition bombs developed abroad. 2200-pound; 440-pound

of an enemy initiating the use of gas in bombing and instead of confining it to the actual attack of combatants, extending it to the bombing of industrial centers. The use of poisonous gases in such operations would be absolutely contrary to the now generally accepted laws of warfare, as gas cannot discriminate between combatant and non-combatant, and if used in bombing against localities outside the theatre of operations, the non-combatant would in the main be affected. Gas would attack personnel and not materiel and would seek out the cellars, subways, underground bomb-proofs and similar places where people usually go for shelter from high-explosive bombs.

The effectiveness of gas depends upon the concentration obtained, which would be greatest, of course, in these places of shelter, as gas is heavier than air and flows to these lower levels. The roofs of buildings would be the safest places during a raid if poisonous gas bombs were used, for there one would be as far removed as possible from the dangers of gas and still have some chance of escape from high-explosive bombs which might be dropped at the same time.

In all probability only the irritating gases would be used in bombing operations against manufacturing plants, for they would permit the enemy to easily interfere with the production of war material without killing the civilian personnel employed in

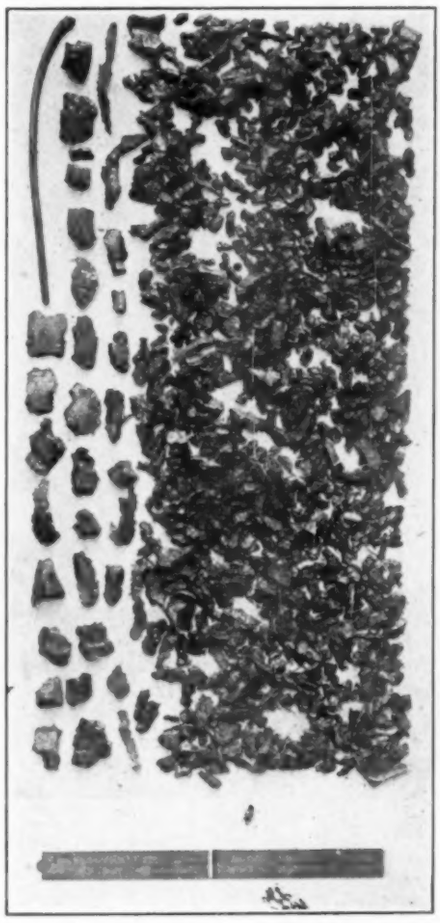
the plants. A certain tear-producing gas dropped in bombs on a plant would effectively stop production over a period of seven to fifteen days if the employees were not equipped with gas masks or special goggles. It is obvious that regu-



Gaps in rows indicate 34 casualties resulting from detonation of 25-pound fragmentation bomb among 140 men in field 343′ x 312′. X shows point of impact of bomb

lar and persistent bombing with such a type of gas bomb might seriously interfere with production over extended periods.

During the World War this country did not have to contend with bombing raids, yet it is rumored that had the war lasted, New York would have been bombed. In the next war we may not be so fortunate. It is very probable that munitions plants and those centers of industry peculiarly important in time of war will be persistently subjected to bombing attacks from the air. In these attacks the enemy will employ highly-developed bombing equipment, from which considerable damage may be expected. Even though our next enemy may be located far distant from this country, there will be no escape from bombing operations. The recent successful trans-Atlantic flights



Fragments resulting from detonation of 25-pound fragmentation bomb

can be taken only as warnings of what may be expected in the future. It, therefore, behooves the manufacturer to appreciate that in the event of war he and his employees must produce their commodities under the ever-present dangers of the bombing raid, and must endure these attacks. The time has arrived when the munition worker may have the opportunity of working literally under fire and will be able to compare actual experiences with his brother from the armies in the field.

The Washington Post of November 27, 1920, comments editorially upon the defenselessness of America with respect to air raids and the need for developing the power to retaliate in kind as being our best defense against such attacks, as follows:

Aerial Warfare

Major General Coe, chief of coast artillery and in that capacity in charge of the defense of seaports, in his annual report directs attention to the fact that owing to the development of military aircraft the security of the United States from attack can no longer be guaranteed. So long as possible hostile operations were confined to surface ships the defense of the American coast depended alone on the number and range of guns available, and even when submarines became a menacing feature of naval warfare coast patrols, together with nets and locating devices, reduced their danger to the minimum. But there appears to be no means of safeguarding this country against possible attacks from the air. To date the limited radius of action possible for airplanes makes them a negligible quantity, but the development of aircraft is progressing so rapidly that in the near future transoceanic navigation of flying machines will be a reality.

Defensive preparations against attack from the air upon American seaports does not appear to be feasible. General Coe states that an estimate has been made for providing the city of Boston with anti-aircraft guns and that the sum needed amounts to $20,000,000. Even then it was proposed to use but little more than half the number of guns that were employed in the defense of Paris. If it would cost $20,000,000 to defend Boston from air raids, the expense of protecting New York doubtless would be much greater. And when the same provision had been made for installing anti-aircraft guns at Philadelphia, Baltimore, Charleston, Savannah and various other large ports on the eastern and western coasts the aggregate expense would be stupendous.

Even then the protection would be only partial. A fleet of hostile airplanes capable of crossing the Atlantic could easily fly 200 or 300 miles inland, where they would find other large cities at their mercy, unless every center of population were fortified against them, which would be entirely impracticable. When it becomes possible to send airplanes on a 3,000-mile offensive cruise, it will be quite possible to extend their bombing operations several hundred miles to interior cities.

It would appear, then, that America's best defense lies in keeping pace with the development in military aviation, so that it may be prepared for offensive operations should this country be threatened from abroad. Nothing is likely to prove more effective in keeping off enemy attacks from the air than the threat of an American attack from the same source.

There is no occasion for reviewing again the unenviable record of this government in the development and use of aviation for military purposes. It constitutes a chapter which most thoughtful citizens would prefer to have erased from our history, and during the war it entailed a cost which is not pleasant to contemplate. But the fact is established that aerial navigation is to have an important place in future wars, and America now stands warned as to her duty as a matter of self preservation. If she fails to keep to the forefront in the science of aviation and in the building of an adequate fleet of the best, fastest and most efficient airships, she will be guilty of criminal neglect and may at any time be forced to pay the penalty of it.

Auto-frettage

By

ALBERT E. GUY

Member A. O. A.

AUTO-FRETTAGE is a French word which, literally translated, means "self-hooping." The word "frette" is the French expression for the hoop, jacket or sleeve which, after being expanded by suitable heating is slipped over a given body or tube and allowed to cool. The inside diameter of the hoop is slightly smaller than the outside diameter of the tube; hence, after cooling, the metal of the tube is in a state of compression and the hoop in one of tension. The hoop is said to be "shrunk" onto the tube. The net result is that the assemblage is then stronger to withstand one given pressure exerted upon the inner walls of the tube than would be one single tube having the same inner and outer diameters as the assemblage, the characteristics of the material being, of course, the same in both cases.

It is easily shown that the compression of the tube increases from the outside to the inside, while the tension of the hoop diminishes from the inside to the outside. This fact indicates that while the strength of the shrunk assemblage is greater than that of a single tube, because the utilization of the material is better in the former, this utilization could be carried further to great advantage by increasing the number of hoops within the same radial thickness, approaching then the ideal conditions of resistance which obtain with the whole transverse section uniformly strained. This idea was carried into effect in the construction of heavy naval artillery, principally. Nowadays the number of hoops is rarely greater than four. Hooping increases the cost and time of production of cannon. It was resorted to for two main reasons, securing greater strength for the gun tube, thereby permitting the use of more powerful charges and thus increasing the range and effects of a given size of material; and because of the difficulty of producing homogeneous and reliable gun steels. It was easier to produce short rings or hoops than long and heavy tubes. The manufacture of gun steels has made enormous progress and is now well in control; nevertheless, there is insistent demand for greater gun power with light mobile materials. This calls, of course, for increased utilization of the strength of metal.

Apart from cost and labor, the number of hoops is limited by the difficulty of machining each hoop accurately, because the greater the number the thinner must be the thickness of the hoop. The maximum effect obtaining with an infinity of extremely thin hoops, it was proposed at one time to simply wrap tightly around the gun tube proper a great length of thin sheet steel, thus forming an assemblage of a large number of layers, which would approach the desired maximum. The difficulties of manufacture at that time were prohibitive and are so even today. A roll of sheet steel cannot be made as a roll of paper, of any desired length and quality. The next conception was the wrapping of an endless steel wire around the gun tube. This was successfully put into effect in England and in the United States. The first layer of wire is applied with a calculated initial tension, and the second is formed by running the wire back over the first, and so on until the desired thickness is obtained. The ends of the wire are securely fastened. The final outer surface is smooth finished, and relatively light hoops are shrunk on, covering the whole length of the wired surface. This is necessary because the wire construction alone would resist satisfactorily the transverse stresses, but would leave the gun weak longitudinally.

Wire construction has the great advantage that the characteristics of the wire itself are very nearly uniform throughout the whole length, whereas, it may be reasonably claimed that a long hoop may be perfect after receiving its last heat treatment and yet develop cracks or other defects, either while being machined or after being assembled on the gun.

The outstanding fact is that the resistance of a cannon must be secured by an assemblage of shrunk hoops or an equivalent wire winding. In either case the process of manufacture is involved and costly.

Strain-setting by Preliminary Firing

When bronze cannon were used almost exclusively, artillerymen observed that after a small number of rounds the bore of a gun had become perceptibly enlarged. The deformation of the inner wall was not due to wear or erosion. Furthermore, after a few additional rounds, it became practically set during the whole service of the gun, that is—the deformation which affected most probably, but to a variable degree, the whole metal of a given transverse section, did not increase further, while the bore wore out, of course, through the usual action of the powder gases and of the projectile.

It was found that the metal around the bore had become hard, the hardness increasing rapidly and radially outwards. Eventually it became the practice, which still obtains in certain parts even with steel guns, to fire initial rounds with increasing charges, so as to deliberately produce a permanent set of the bore, the latter being afterwards smooth finished to size before the gun was finally delivered to service.

The metal was set through the development of intense strains generated by the powder effects, and whether or not this setting affected regularly the whole cross section of the gun or merely increased the hardness and density of a number of layers immediately surrounding the bore, it is thought proper to employ the term "strainset" to express in general the condition of the permanently deformed metal.

Strain-setting by Mandrelling

In order to make sure the initial deformation of the gun

tube, also to intensify it, another process was used which consisted of forcing one or more olive-shaped mandrels throughout the whole length of the bore. This was done by means of an hydraulic press, the gun tube resting firmly at one end against an abutment, and the mandrel attached to a strong rod was drawn through. The metal immediately surrounding the bore was "cold worked;" this was originally the main point sought for; of course, all the metal of a transverse section was affected by the forcing, but most probably not to the full extent desirable. The process was a violent one and required the exercise of great care in order to avoid tearing the bore surface and fissuring the neighboring layers. Besides, with the thickness of the gun tube tapering from the powder chamber to the muzzle, and the forcing being uniform along the bore, the metal was less deformed in the region of higher pressure, where it needed deformation most, than further along the chase where the gas pressure is constantly dropping. This process was devised and put into practice by the Austrian General Von Uchatius, in 1873.

It may be interesting to note that shortly after the entrance of this country into the great war, among the many schemes proposed as essential to insure us victory—proposed for substantial consideration, of course—the Uchatius method of gun making was brought forward as a novelty. It was indeed a novelty as regards the results claimed for it and the sale price quoted. It was carefully investigated and not accepted.

Strain-setting by Initial Internal Cooling

Most interesting work in this line was done by the Ordnance Department in 1857 and 1858. At that time the guns were made of cast iron and, in spite of extraordinary precautions in selecting and casting the metal, the life of these guns was very short. It was then that Captain Rodman introduced a new method which consisted mainly in circulating cooling water through the core barrel of a hollow cast gun. In the former way the mold was made of green sand and the core of dry sand, prepared in the usual manner. The heat from the molten mass could only escape from the exterior surface of the gun into the moist sand of the mold and its surrounding support of earth. The result was that this exterior surface set first, the layers following in succession, radially to the core surface; hence the cooled metal was in a state of contraction on the outside, while the interior surface was in tension—the layers, from one surface to the other, gradually losing in compression to gain in tension. This was, of course, just the reverse of what is required of gun construction, and particularly so with cast iron, which is much weaker in tension than in compression.

Captain Rodman very ingeniously reversed the process, and by forcing cooling water through the special core barrel caused the inner layers to contract first and the outer layers to be in tension. The 8-inch and 10-inch "Columbiads" made by Captain Rodman amply proved the truth of his contentions and when fired to destruction in comparative tests with the older type guns, showed a life about five times that of the regular cast guns.

It might be claimed, quite reasonably, that Captain Rodman was the first to develop and put into successful practice a process of auto-frettage. Effectively, the intensive cooling of the inner layers of the hot-metal cylinder produced a special adjustment of each layer which was somewhat like the condition obtaining with wire winding. Each successive layer from the inside outwards acted as one thin hoop which exerted a radial pressure upon the cylindrical mass it encircled. Owing to the constitution of the metal, cast iron, the adjustment of the stresses throughout the mass may not have given the ideal hooping condition mentioned before, but there can be no doubt that the Rodman gun was, in effect, auto-hooped; that is, auto-fretted.

Strain-setting by Auto-frettage

All ordnance text-books have adhered thus far to the very strict rule which limits the greatest strain developed in a gun body to the value corresponding to the strain produced by a tensile stress equal to the elastic limit of the material. That is understood to be the very extreme limit, and the design should be established for a value somewhat lower. Beyond that limit, permanent deformation takes place, and that can not be admitted to develop in a finished gun, for obvious reasons. This rule is in perfect accord with engineering practice which permits only stresses capable of developing none but elastic strains. The designers confined themselves, therefore, to a snug position within the classic field. There is vague fear, rather widely spread, that a member subjected to a stress extending beyond that field will suffer not only one corresponding permanent deformation, but also that the latter, once developed, will keep on increasing; in other words, that the member has become permanently weakened. This fear is justified by numerous occurrences, by the breaking or destruction of structures in which one or several members became overstressed.

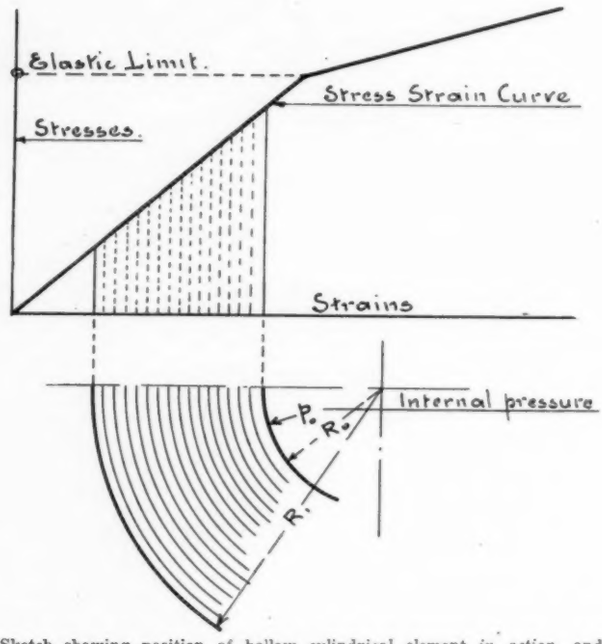
It might be shown very readily that the trouble developed through the actual weakening of one member, and that this weakening brought about the unstability of the system, thereby increasing furthermore the excess stress of the member, causing buckling or rupture, and general disaster.

Inspection of the usual stress-strain curve established from a tensile test on standard-size steel bar shows that the deformation increases proportionately with the load until the elastic limit is reached; beyond this, the deformation, or strain, increases at a faster rate until, finally, rupture takes place. The important point in this case is that to produce additional deformation once the elastic limit is passed, requires increasing effort. Consequently, if the elastic limit of a certain steel bar had been found by test to equal 60,000 pounds per square inch, and that the stress had afterwards been brought up to 65,000 pounds, while under this load, the resulting strain would be composed of one elastic elongation, which would disappear upon removal of the load, and of another elongation which would not disappear; that is, the permanent deformation.

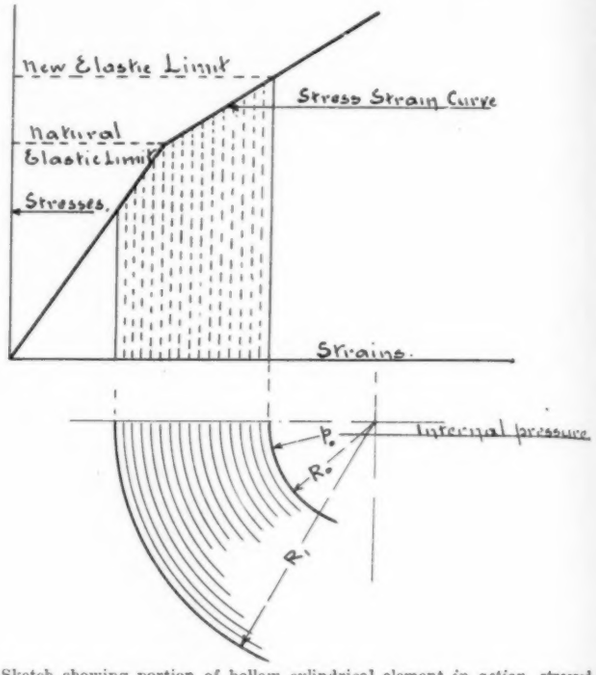
With this load removed, the bar would then be found to have increased in length. This, in a working member of a structure, may be very objectionable, of course. But with any static load less than 65,000 pounds applied to the bar, the total deformation will always remain less than the maximum reached under the latter load, and the permanent strain does not increase. It is only when the load exceeds 65,000 pounds that both permanent and elastic deformations are seen to increase.

The obvious conclusion is that a member, statically stressed to a point quite beyond the natural elastic limit, will be entirely safe under any static load extending below that point and that, furthermore, the point may be considered as a new elastic limit, and adopted as such for practical purposes.

This view is not new; it was aired out particularly in 1874 by Col. G. Rosset, of the Turin Arsenal, in a paper on the "Strength of Guns." This paper was translated in part by our Ordnance Department in No. 11 of the



Sketch showing position of hollow cylindrical element *in action*, and relativity of stress and strain for the various layers of the section, within the Elastic Limit.



Sketch showing portion of hollow cylindrical element *in action*, stressed to the new Elastic Limit acquired by auto-frettage process.

"Notes on the Construction of Ordnance." Colonel Rosset pointed out that beyond the elastic zone the metal did not lose its elastic properties, but, on the contrary, these were increased while remaining practically proportional to the loads applied, the only change noted being a rapidly increasing permanent deformation. He gave the name of "Special Elasticity" to this continued elastic property beyond the natural limit and pointed out its usefulness. He also suggested a number of means for imparting permanent increased elasticity to materials of engineering; however, while this would apply satisfactorily in some instances to relatively small-size parts, they can not be considered practical in a general sense.

In passing, it might be said that strainsetting by means of rolling, swaging and hammering, which is so useful in innumerable cases for increasing the qualities of materials, is not to be considered on the same plane with auto-frettage, because there are radical differences between the processes.

As applied to a hollow cylinder, or to a gun, auto-frettage consists in applying an interior pressure, preferably by means of hydraulic apparatus, of such intensity as to cause deformation of the inner layers much beyond that corresponding to the natural elastic limit. Thus, for instance, the inner diameter might be made 4 per cent longer, and, consequently, that of each succeeding layer would be stretched to a lessening degree until the outer layer would just reach the elastic limit. This deformation, under pressure, would comprise one permanent set and one elastic strain which would disappear with the removal of the pressure. Of course, the permissible interior deformation is based upon the ratio of outer and inner diameters, upon the physical qualities of the metal and particularly upon the paramount condition of keeping the inner layers free from fissures and breaks.

Precautions must also be taken so that upon removal of pressure—that is, "in returning to rest"—the material of the inner fibers, which will then be under intense compression, will not now be further deformed and weakened by these compressive stresses.

In action—that is, under interior pressure—all the layers are in a state of tension varying, of course, with the radial position of any given layer; returning to rest, all the layers tend to return to their original lengths, but, because of the permanent deformation intentionally produced, the inner layer, for instance, if it could be separated from the surrounding mass, would be set to a new length greater than the original and smaller than that developed in action; connected as it is with the mass, it is then compressed by the combined efforts of all the surrounding layers. The result is that the whole body of the solid hollow cylinder is in a state of compression, greatest at the interior wall and least at the exterior, and is practically in the same condition as if it were formed of a very large number of thin concentric sleeves assembled together by shrinkage. Hence, the name "self-hooping, auto-shrinkage or auto-frettage," this latter originated by the French technicians who originated the process themselves.

In the foregoing, the expression "cylindrical layers," as applied to a solid hollow cylinder, is intended in the usual and most convenient sense where the concept "layer" is used to designate a very thin cylindrical sleeve, the whole cylinder being assumed as composed of a large number of such superposed concentric sleeves.

To say that the strainset cylinder is now in a state of compression, means that a state of pressure has been radially generated between any two adjacent layers. It does not mean that all the layers are circumferentially stressed in compression. Beginning at the inner wall, the layers are stressed in compression to a degree varying with their radii up to a certain radial length where the corresponding layer is exactly of the size it would have returned to if, after distension, it had been detached from the mass and left to assume a natural rest. From this point outward, the layers are stressed in tension to a degree increasing with the radial length, becoming maximum on the outer wall of the cylinder. The layer enjoying its natural rest may be said, for convenience, to represent the neutral axis of the strainset cylinder.

The deformed cylinder may now be turned down and bored to its intended finished size. These operations produce a change of stress and of the neutral axis throughout the section, and weaken the cylinder. That, of course, must be taken into consideration at the start, and the auto-frettage pressure must be calculated accordingly.

The final result is that the finished strainset cylinder may be subjected to an internal pressure slightly inferior to the pressure of auto-frettage without suffering any further permanent deformation; and that pressure is greatly superior to that which the cylinder could bear, in its natural state, without suffering a distension which would put it out of service.

For example, take two hollow cylinders, finished to a ratio of outer to inner diameters equal to three; one of these being left in its natural state and the other auto-fretted to a limited interior deformation of 3 per cent. Let the natural elastic limit of the metal be 63,000 pounds per square inch for both cylinders. According to ordnance formulas, an internal pressure of 39,800 pounds per square inch will bring the first cylinder to its natural elastic limit at the bore; the auto-fretted cylinder will sustain an internal pressure of 81,000 pounds per square inch, which will just bring the bore layer to its new elastic limit. Upon the removal of these pressures the cylinders will, theoretically, return to their finished sizes without permanent deformation.

This shows that, by the use of the new process applied to cannon design, a gun of given weight may sustain a much greater charge than that hitherto used in service and discharge its regular projectile at a greatly increased muzzle velocity, and consequently much extended range.

Unfortunately, a cannon has a thickness of tube diminishing from the powder chamber to the muzzle, in order to conform with the variation of pressure of the powder gases. It is therefore impossible to employ a uniform auto-frettage pressure throughout the length of the cannon. Great care must be exercised in grading that pressure. It is not that gradation itself which offers the greatest difficulty, but, rather, the correct calculation of the varying pressure, so as to obtain the predetermined improved strength of the gun, within the set limits of deformation.

This strain-setting process does not improve the ultimate strength of the metal, at least, the present state of the matter does not indicate improvement very clearly. Thus a gun steel of 65,000 elastic and 95,000 ultimate limits may have the first raised to 78,000 or 80,000, while the rupture limit would remain but slightly increased. These figures, however, refer to the original sectional area of the bar specimen. Therefore, while the elastic strength of a given gun might be increased by 15,000 pounds, the point of rupture would remain the same.

Then, of what advantage is auto-frettage?

A cannon is now formed of hollow cylinders, each finished with the utmost precision, and assembled with likewise care. The metal of each part is specially treated and tested before used. When the cannon is entirely finished, and that includes handling and firing mechanisms, it is proof fired. Then defects may appear, perhaps sufficient to cause the rejection of the finished tube.

The auto-fretted gun is made of one tube, forged closely to final size. The tube is turned and bored to "prepared" size and then subjected to a varying internal pressure, as predetermined. During the application of pressure close observation and spot measurements are certain to reveal material defects. After which the gun is finished outside and inside, assembled and ready for service tests.

It is obvious that auto-frettage ensures economy of time, of labor and material. In war-time production a large number of gun tubes may be distended simultaneously and quickly, since the process may be accomplished easily in one day. The main point is that, likewise with boilers and engine cylinders, the apparatus has been subjected successfully to a greater stress than may obtain in service and is practically free from additional permanent deformation. Besides, as already pointed out, the efficiency of a given size gun may, by this process, be considerably increased, since a greater range may be obtained through the use of a larger charge.

Actual Theories and Needed Experiments

It seems that the first theory of auto-frettage was given in 1884 by Captain Duguet, of the French Artillery. It may be found in his work on the "Limit of Elasticity of Solid Bodies," published in 1895, section No. 36, page 185, of the second volume which deals with "the elastic resistance of a tube originally deformed." He treats, at various places, of the advantages of utilizing interior hydraulic pressures for strain-setting the metal, and gives valuable formulas.

Captain Duguct developed the theory of sliding of material parts in a solid body under stress to a larger extent than had been done before. To-day physicists and elasticians have practically abandoned it, as well as that of maximum stress, and follow, in general, that of deformation or strain. That is, Duguet claims that a stressed body reaches its elastic limit through molecular sliding; Lame, a most celebrated elastician, established that the elastic limit was reached when the greatest stress applied was equal to that which, in direct tensile test, would precisely equal the elastic limit; to St. Venant is due the strain theory, generally adopted now, which establishes that when the greatest strain resulting from a combination of stresses equals that produced by the elastic limit in tensile test, that limit is actually reached for the body.

Colonel Jacob, of the French Naval Ordnance, took up the question in 1907, and later, in 1912, he published a memoir on "The Elastic Resistance of Auto-fretted Tubes." Colonel Jacob has just published a work in two volumes (1920) on the "Resistance of Cannon," in which he treats fully of auto-frettage. He adopted entirely the St. Venant strain theory.

Finally comes Colonel Malaval, of the French Naval Ordnance, who was associated with Colonel Jacob for quite a long time and conducted the experiments with the first guns made in France, by auto-frettage. He has written extensively on the subject, but, unfortunately, solely for the benefit of the French ordnance schools. It is understood, however, that he will shortly publish a book which can not fail to be highly interesting to the engineering public. He has gone back to the Duguet and Lame theories and differs, consequently, from Colonel Jacob.

From information gathered by our own ordnance officers it would seem that the French practicians are somewhat dubious of the various extant theories and content themselves with keeping the distension of the tube within 4 per cent of the inner diameter.

The Ordnance Department is naturally anxious to benefit of any discovery which may lead to the improvement of war materials. But it realizes fully the gravity of making a wrong step. If auto-frettage proves true to the claim made for it, that means reorganization of our materiels, with vastly improved methods of manufacture, quick and safe production, economy in labor and material and greater efficiency.

Quite a number of our new cannon have been designed for auto-frettage manufacture, and while it would be easy, with the special apparatus at hand, to perform the work, it is deemed preferable, particularly in view of the lack of agreement of the various existing theories, to develop a carefully planned series of experiments with simple specimens of bars and tubes and obtain thereby, practical and reliable, first-hand information upon which to build a theory as well as the guns.

Preliminary experiments conducted at the Bureau of Standards and at the Watertown Arsenal, have already proven so successful as to permit the writer to advance several facts of basic importance to the engineering profession. For instance, it seems established that there is only one elasticity in a body, that of the mass affected by stress, instead of the old notion of tensive, compressive, torsive, etc., elasticities.

The so-called Poisson ratio of lateral to axial strains instead of being taken as practically constant, with a value between one-fourth and three-eighths, varies between zero at no load to about one twenty-sixth at the elastic limit, and thence from to about one-half toward the rupture point.

The combination of stresses does not take place as assumed by St. Venant and his followers; the resulting strains simply add, and where the total equals the strain corresponding to the elastic limit, that limit is actually reached by the body.

It would be an imposition to dilate further on the subject, particularly so when this article was originally intended to be brief. The above will show the interest attached by the Ordnance Department to such an important question, and it is hoped that the results of the experiments now in course of execution will prove of use, not only in cannon work, but in many other fields, and they are oriented accordingly.

[Major Guy, author of the above article, is engaged in special research work for the Artillery Division, Office of the Chief of Ordnance. While the program of experimental work originally contemplated only the determination of the physical constants of the elasticity and resistance of materials used in Ordnance construction, preliminary work already completed indicates that the results of Major Guy's investigations may have an almost revolutionary effect upon the present conception of the theory of elasticity and its application to practice.

We are glad to announce to the engineering world that Major Guy has agreed to publish in the columns of ARMY ORDNANCE the results of these important researches.—ED.]

Notes on Depreciation

By

J. D. SKINNER

Member A. O. A.

Definitions of Depreciation (*Webster*): (*a*) The *act* or *process* of decreasing the value of equipment or plant facilities. (*b*) The *amount* of such shrinkage for a definite length of time.

IT is common experience that equipment deteriorates from the day it is completed, slowly at first, more rapidly later on until after a longer or shorter "life," depending upon its nature, service, etc., it reaches a condition that disqualifies it properly to perform the functions for which it was designed. While repairs and betterments will lengthen its life, they cannot prevent its ultimate demise.

There are four principal causes of depreciation:

1. Destructive effect of the elements and time.
2. Wear and tear which cannot be remedied by repairs.
3. Obsolescence through the introduction of improved facilities in competing plants.
4. Decrease in the demand for the particular article (Commercial depreciation).

Although virtually all of the great nations of Europe have enacted laws prohibiting the payment of dividends before charging off depreciation, until a few years ago the true nature of depreciation was not generally understood in the United States. Many of our courts formerly held that depreciation was not an element of cost and hence should not be deducted from gross earnings. For example, the Supreme Court rendered the following decision: "We are clearly of the opinion that it is not a proper charge. Only such expenditures as are actually made can with any propriety be claimed as a deduction from earnings."

That this decision has been inferentially if not actually reversed is apparent from the rulings of the Interstate Commerce Commission in regard to the depreciation of railroad equipment.

As conditions vary so much it is not safe to establish standard rates of depreciation, but each case must be judged on its individual merits in the light of experience. For example, a stone or concrete storehouse may have a life of fifty years or more while a corrugated iron building subject to the shocks of heavy machinery and to the corrosive effects of gases, might not be serviceable one quarter of that time. Machinery depreciates more rapidly than buildings, but varies within wide limits.

As a rough guide for favorable conditions, a commission of the National Machine Tool Builders recommended an annual depreciation from the first cost of 10 per cent on machinery, 5 per cent on frame buildings and 3 per cent on brick buildings.

The Residual or Salvage Value is the sum realized from the sale of the facility at the end of its life, when it is generally sold as scrap. Cases occur where the residual value is negative, that is where it costs more to remove the machine than it brings as scrap, for instance the salvaging of a worn out steam boiler from a torpedo boat.

METHODS OF DISTRIBUTING TOTAL DEPRECIATION.

A. Uniform Depreciation.—The simplest and most generally employed method is based on the assumption that depreciation is uniform throughout the life. For example, if the first cost is $1,000.00, the residual value $250.00 and the life five years, the total depreciation being $750.00, one-fifth of this or $150.00 is to be charged off annually. Hence the annual depreciation rate is 15 per cent of the first cost. This is represented graphically in Fig. 1.

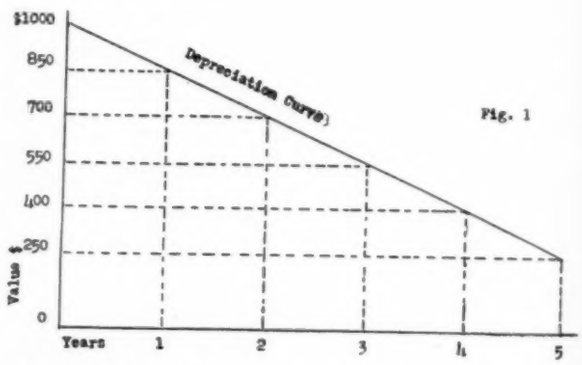


Fig. 1

From Fig. 1 it is seen that at the end of any year the remaining value is the ordinate to the curve for that year. Thus at the end of the second year, the remaining value is $700.00.

By this method the charge for depreciation for the first year is the same as that for the last year, whereas the facility actually decreased little in value at first, but very largely during the latter part of its life. Furthermore, as the repairs are always less at first than later on, the burden can be more equitably distributed by charging a relatively large depreciation during the early years of the life and a relatively small depreciation during the latter portion of the life when the repairs are heavy. Methods "B" and "C" have been devised to accomplish this purpose.

B. Constant Annual Percentage of the Remaining Value.—It is required to find a rate such that the product of this and the remaining value will give a series of decreasing annual depreciations throughout the life, whose sum equals the total depreciation.

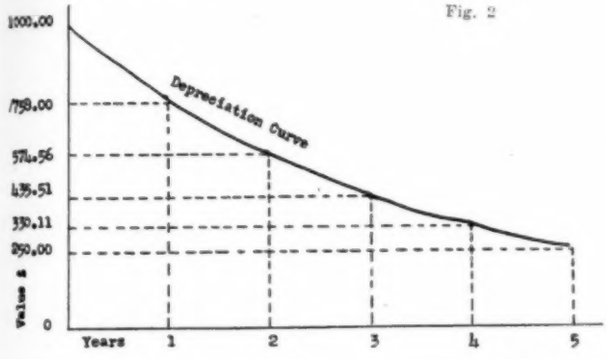
If C = first cost,
d = residual or salvage value at the end of the life,
n = the number of years of life,
x = the percentage (expressed as a decimal) to be charged off annually,

then it can be shown that $\log (1-x) = \frac{1}{n} \log \frac{d}{C}$ (1)

(See appendix A.)

From the above equation the value of x can be readily found but tables are available making it unnecessary to use the formula. For example, if the first cost is $1,000.00, the residual value $250.00 and the life five years, the annual depreciation rate or $x = 0.242$. Using this rate the depreciation for the first year is $242.00. The remaining value at the end of the first year will then be $1,000.00 − $242.00 or $758.00. The depreciation for the second year will therefore be 0.242 times $758.00 or $183.44. The remaining value at the end of the second year being $574.56, the depreciation for the third year is 0.242 times the latter amount or $139.05. This process may be continued for the entire life, the sum of all the depreciations amounting to $750.00 or the total depreciation. This is illustrated graphically in Fig. 2.

Fig. 2



C. Cole's Method.—The depreciation rate (in the form of a fraction) is found as follows:

Add the integers comprising the number of years of life. Use this sum for the denominator. For the first year, the numerator of the depreciation fraction is the total number of years of life. For the second year, the numerator is the total number less one, etc. Applying this to the last example, we have—

Denominator = 1+2+3+4+5 = 15
Depreciation fraction for first year = 5/15
Depreciation fraction for second year = 4/15
Depreciation fraction for third year = 3/15 and so on.

The total depreciation being $750.00, the amount to be charged off the first year is 5/15 of $750.00 or $250.00; that of the second year 4/15 of $750.00 or $200.00; that for the third year 3/15 of $750.00 or $150.00, and so on. This is represented graphically in Fig. 3.

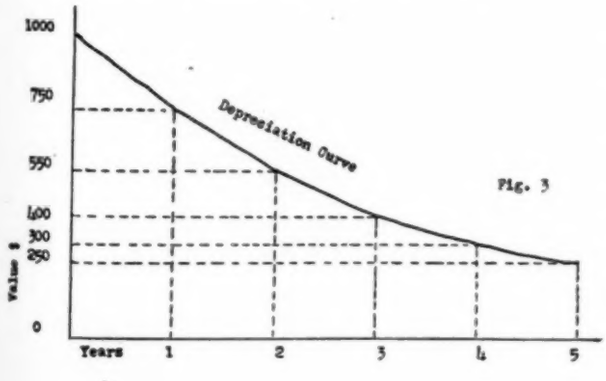


Fig. 3

D. Constant Annual Rate Based on Compound Interest.—This method is less frequently employed in industrial depreciation, being more applicable to the retirement of financial obligations such as bonds, mortgages, etc. The problem is to determine that sum, known as a "sinking fund," which if set aside each year during the life will at a given rate of compound interest entirely extinguish the total depreciation.

Let S = this sum,
P = the principal,
r = interest on one dollar for one year,
R = the amount of one dollar for one year,
n = life in years,
A = amount of P for n years.

Then it may be shown that $S = \frac{A(R-1)}{R^n - 1}$ (2)

(See appendix B.)

Tables are available giving this information without making it necessary to use formula (2). Applying this to the given problem, we have from annuity tables calculated by (2):

Annual charge to extinguish $100.00 at end of five years at an assumed compound interest rate of 4½ per cent = $18.28. Therefore the annual charge to extinguish $750.00 is—

$$\frac{750}{100} \times \$18.28 = \$137.10$$

The total amount set aside during the life will be—

$$5 \times \$137.10 = \$685.50$$

Hence the total interest earned = $750.00 − $685.50 = $64.50 or $12.90 annually.

This is also evident by comparing the average annual depreciation of $150.00 (see Method A) with this sinking fund of $137.10, the difference being $12.90 the annual interest earned. This is illustrated in Fig. 4.

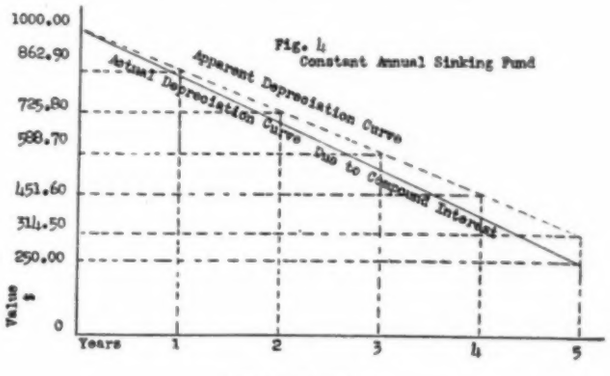


Fig. 4 Constant Annual Sinking Fund

AMORTIZATION.

Definitions (Webster)—

Amortize.—To clear off, liquidate or otherwise extinguish a debt, usually by a sinking fund.

Amortization.—(*a*) Act or process of amortizing; (*b*) the sum so applied.

It should be clearly borne in mind that depreciation occurs, owing to the causes mentioned on page No. 1, whether or not the owner of the equipment provides against the evil day when its value except as scrap will have been entirely consumed. This process of laying aside a sum which will pay for the article of equipment is amortization in the sense of definition (*a*). The very derivation of the word is significant as this process is one that makes as if dead the original investment

charge. Amortization, definition (*b*), has been confounded with the fourth cause of depreciation, as mentioned on page 130. It is thought preferable to use the term "commercial depreciation" and confine amortization to the sense defined in (*a*). This is clearly stated in paragraph B in Supply Circular No. 126, defining Costs pertaining to War Contracts, viz:

"*B. Commercial Depreciation* of manufacturing facilities provided by the contractor especially to meet the requirements of this contract shall be allowed as an element of cost.

Commercial depreciation covers losses in value due to commercial conditions not provided for in ordinary depreciation as defined in the preceding section. The important factors of commercial depreciation are—

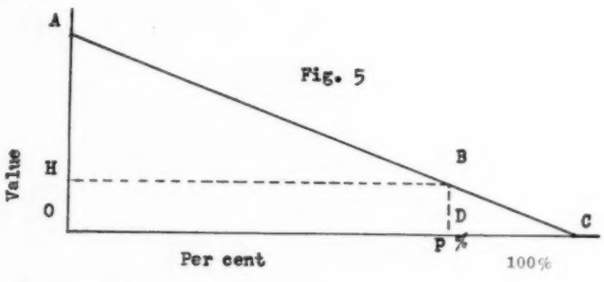
(*a*) Decline in commercial value of facilities upon termination of the contract due to decreased demand for the products which they are capable of manufacturing; and

(*b*) Abnormal cost of increased facilities due to war conditions.

Allowances for commercial depreciation shall be determined by the contracting officer, and shall represent the difference between the original cost of such increased facilities, including cost of installation, and their fair commercial value to the contractor at the termination of the contract, less ordinary depreciation already deducted."

Under (*a*) it becomes necessary to determine what portion of commercial depreciation shall be borne by the United States in case a contract is terminated by the Government prior to its completion thus leaving the contractor with a facility on his hands that has not been amortized through the profits that would have accrued had he completed his order.

Case I.—Where a special facility (such as a loading machine) has no scrap value after the contractor's order has been completed or work permanently stopped on same.



In Fig. 5, let—

OA be the total first cost of the facility,
C be the point of no salvage value if contract is 100 per cent completed,
AC be the assumed depreciation curve (Method A),
D be the point at which work was stopped on the contract (*p* per cent completed),
B be the corresponding residual value of the facility.

Since there is no salvage value, the entire cost OA must be amortized. At *p* per cent completion, there still remains DB to be amortized. Hence this is the amount to be borne by the United States.

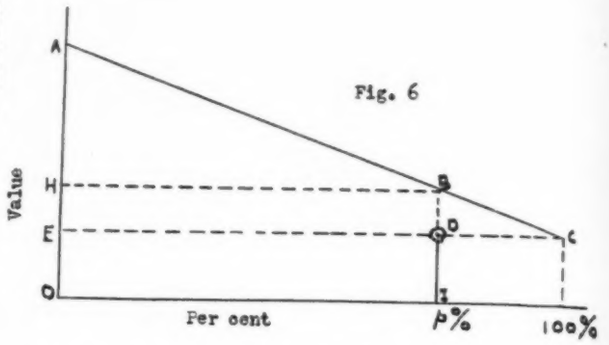
From the figure, $\frac{DB}{OA} = \frac{CD}{CO}$

Whence $DB = (1-p)OA$ (5)

Applying this to the example and assuming that the contract had been 75 per cent completed:

$$DB = (1-0.75)\ (1000) = (0.25)\ (1000) = \$250.00$$

Case II.—Where the special facility has a salvage value at the time work terminated, this value being found by appraisal.



In Fig. 6, let ID = salvage value when contract is *p* per cent completed.

It is simplest to assume the depreciation curve that of Method A and that the salvage value if the contract had been completed, would be the same as when work stopped.

Project ED to meet in C the ordinate through 100 per cent.

Then AC is the depreciation curve and the amount to be amortized is AE.

The portion to be borne by U. S. is DB, which may be shown to be

$$DB = (1.00-p)EA \qquad (6)$$

Applying this to the example and remembering that EA = OA − OE:

$$DB = (1.00-0.75)\ (1000-250)$$
$$= \$187.50$$

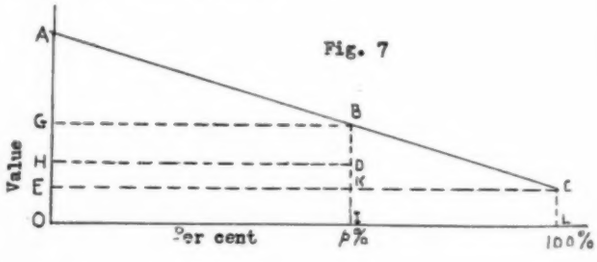
N. B.—It is to be noted that in both these cases, the contractor retains the facility.

GENERAL RULE

(*Based on assumptions in Cases I and II.*)

From first cost deduct appraised salvage value at time work permanently stopped, thus finding the amount to be amortized. The U. S. bears that portion of this amount represented by the ratio of the uncompleted part of the contract to the total contract.

Case III.—Where the salvage value if the contract had been completed is known.



In Fig. 7, let LC be the known salvage value at the time the contract would have been completed and ID the appraised salvage value when work was stopped on the contract.

Then AC is the depreciation curve and the actual amount to be amortized is AH. The portion to be borne by the U. S. is DB.

To find DB:

$$DB = KB - KD \text{ and since } \frac{KB}{EA} = \frac{CK}{CE} = \frac{1.00-p}{1.00}$$

$$DB = EA(1-p) - KD \qquad (7)$$

Applying (7) to the example and assuming $150.00 as the salvage value if the contract had been completed:

$$DB = 850(1.00-0.75) - 100.$$

whence DB = $112.50

In the three cases given above, the straight line has been assumed as adequately representing the law of depreciation since where an appraised value is a function of the amount to be amortized, it is generally sufficient to assume a uniform rate of depreciation.

Appendix A.

Problem—To find the fixed percentage of the remaining value at the end of each year that must be annually charged off as depreciation in order to amortize the difference between first cost and residual value during the given life of the equipment.

Let C = first cost.
d = residual or salvage value at end of life.
n = number of years of life.
x = percentage (expressed as a decimal) to be charged off annually.

then $C-d$ = amount to be amortized.

Now the depreciation at end of 1st year $= Cx$

Remaining value at end of 1st year $= C - Cx = C(1-x)$

Depreciation at end of second year $= xC(1-x)$

Remaining value at end of 2nd year $= C(1-x) - Cx(1-x) = (C-Cx)(1-x) = C(1-x)^2$

Depreciation at end of 3rd year $= xC(1-x)^2$

Remaining value at end of 3rd year $= C(1-x)^2 - Cx(1-x)^2 = (C-Cx)(1-x)^2 = C(1-x)^3$

Depreciation at end of 4th year $= xC(1-x)^3$

Remaining value at end of 4th year $= C(1-x)^3 - Cx(1-x)^3 = (C-Cx)(1-x)^3 = C(1-x)^4$

Depreciation at end of nth year $= xC(1-x)^{n-1}$

Remaining value at end of nth year $= C(1-x)^n$

∴ The sum of all the depreciations up to the end of the nth year or $C-d$ is:

$$C-d = Cx + Cx(1-x) + Cx(1-x)^2 + Cx(1-x)^3 + \ldots + Cx(1-x)^{n-2} + Cx(1-x)^{n-1} \qquad (1)$$

Multiplying both members by $(1-x)$:

$$(1-x)(C-d) = Cx(1-x) + Cx(1-x)^2 + Cx(1-x)^3 + Cx(1-x)^4 + \ldots + Cx(1-x)^{n-1} + Cx(1-x)^n$$

Subtracting (1), $(1-x)(C-d) - (C-d) = -Cx + Cx(1-x)^n$

$$(C-d)(1-x-1) = -Cx + Cx(1-x)^n$$

$$(C-d)(-x) = -Cx[1-(1-x)^n]$$

$$C-d = C[1-(1-x)^n]$$

$$C-d = C - C(1-x)^n$$

$$d = C(1-x)^n$$

$$(1-x)^n = \frac{d}{C}$$

$$1-x = \left(\frac{d}{C}\right)^{\frac{1}{n}}$$

$$\therefore \log(1-x) = \frac{1}{n}\log\left(\frac{d}{C}\right) \qquad (2)$$

Example:

Given C = $1,000.00.
d = $250.00.
n = 5 years.
∴ $C-d$ = $750.00 the amount to be amortized.

Substituting in (2):

$$\log(1-x) = \frac{1}{5}\log\left(\frac{250}{1000}\right)$$

$$= \frac{1}{5}\log(0.2500)$$

$\log(0.2500) = 9.39794-10$

adding and subtracting 40 $\quad 40. \quad -40$

$5)49.39794--50$

$9.87959-10$

$= 9.87959-10$

$\therefore 1-x = 0.7579$

$\therefore x = 1-0.7579$

or $x = 0.2421$ (Call it 0.242).

Proof:

Year.	*Depreciation for year.*	*Remaining value at end of year.*
1	242.00	758.00
2	183.44	574.56
3	139.05	435.51
4	105.40	330.11
5	79.82	250.40
	749.71	

Appendix B.

SINKING FUND.

Let P = Principal
r = Interest on $1.00 for 1 year
R = Amount of $1.00 for 1 year
n = Number of years
A = Amount of P for n years
S = Sinking Fund to be set apart at the end of each year and put at compound interest.

Then the value of S at the end of the

1st year = S
2nd year = $S + SR$
3d year = $S + SR + SR^2$
4th year = $S + SR + SR^2 + SR^3$
nth year = $S + SR + SR^2 + SR^3 + \ldots SR^{n-2} + SR^{n-1}$

That is A =

Multiplying by R, $AR = SR + SR^2 + SR^3 + SR^4 + \ldots SR^{n-2} + SR^{n-1} + SR^n$ (1)

Subtracting (1), $AR - A = -S + SR^n$

$$S(R^n - 1) = A(R-1)$$

$$\therefore S = \frac{A(R-1)}{R^n - 1} \qquad (2)$$

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Submachine Guns

By

A. B. RICHESON
Member A. O. A

[Major Richeson, the author of the following article, commanded a battalion of infantry in the 91st Division overseas, and was invalided home as the result of a speaking acquaintance with a German machine gun in the Meuse-Argonne battle. He is a writer who has followed the development of automatic arms for years, and has written several articles on the subject.—Ed.]

THE SUBMACHINE GUN makes its debut in the world of firearms. This little prodigy in the field of automatic arms is a light machine gun reduced to the form and dimensions of a large pistol. Using 100-round, drum-shaped magazines the gun delivers a stream of several hundred shots per minute, firing the man-stopping .45 caliber army automatic-pistol cartridge.

Three new mechanical principles are embodied in the gun to produce its extreme lightness and simplicity, combined with sturdiness and reliability of functioning. These engineering features, the wedge lock, the oiling device, and the new disc magazine feed, were worked out by the Auto-Ordnance Corporation of New York, headed by Gen. John T. Thompson, retired, who directed American small arms production during the late war.

Five years of work have brought this weapon to its final completed state, and it has successfully undergone the Springfield Armory functioning test, and demonstrated its capabilities on the Quantico and Camp Perry rifle ranges. The New York Metropolitan Police already have adopted it and purchased a number for riot work.

The military possibilities of the gun for airplanes, protection of artillery and heavy machine guns in action, and for cavalry use, apparently are limited only by the ingenuity of officers of those services. They are suggested by a statement from the Air Service that a single airplane could mount and fight 50 Submachine guns, or could transport that many or more for land combat.

With this introduction, a more detailed explanation is now in order of the three new features of the weapon, which the inventors expect to revolutionize automatic arms. They will be described in order, the wedge lock, the oiling device, and the disc magazine feed, although all are equally important in this weapon.

The Breech-lock Problem

The problem of a breech lock for an automatic gun, to combine extreme simplicity and absolute safety with certainty of operation, has been solved in this weapon, and the principle also has been applied to high-power rifles and cannon of the smaller calibers.

In its application to the Submachine gun, a small wedge, weighing a few ounces, takes the place of all the numerous, complicated and weighty recoil mechanisms, rods, pistons, cylinders, springs and other parts, used in other types of automatic and machine guns.

The discovery of the part played by the force of adhesion in locking breech mechanisms under heavy bore pressures developed at the moment of firing, was utilized by Commander Blish of the Navy in some wedge type breech block experiments several years ago. The evolution of this idea has enabled the inventors to turn out the Submachine gun.

The Naval Ordnance Bureau, following the experiments in 1915, reported as follows:

"In any breech closure consisting of a breech plug housed in a suitable housing, and having two pressure resisting surfaces, the forward surface disposed normally to the axis of the bore and the rear surface inclined thereto and bearing upon a suitable surface of the housing, the force of adhesion will immovably fix or clamp the breech block under heavy pressure, but at a comparatively small pressure whose value depends upon the inclination of the two surfaces referred to, the force of adhesion ceases to act and the breech block is rendered free to move under the influence of the forces then existing.

"The inventor has experimented with a simple wedge type of breech closure and the models submitted to the Board were of this type. He has varied the angle of inclination of the surfaces of the wedge and has found that the smaller the inclination the smaller the pressure at which adhesion ceases, but has not attempted to formulate the relation existing between these quantities. He also states that this cessation of adhesion under diminishing pressures apparently is very abrupt, and it is logical to infer that under increasing pressure this force of adhesion is called into existence in an equally abrupt manner.

"Adhesion is a molecular force which binds together the surface of molecules of two bodies at the common surface of contact. Everything goes to show that intimacy of contact conduces to the existence of adhesion. If two bodies are pressed together, the pressure increases the intimacy of contact, especially if the pressure be great, and thus indirectly causes the surfaces to adhere. If the pressure be gradually reduced the contact becomes less perfect and a point is reached where the contact is not sufficiently perfect for the surface to adhere—adhesion ceases and the surfaces are free to move under the influence of such other forces as may exist at the time.

"So long as the surfaces do adhere they are locked together by the force of adhesion, and resist any sliding upon each other much as the force of cohesion resists the sliding of the molecules of a continuous body under the influence of a shearing force.

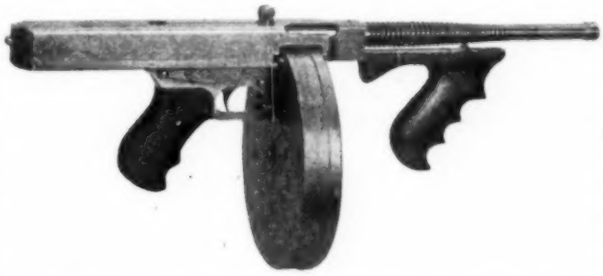
"Two remarkable facts were made manifest by experiments. (1) The breech opened when the wedge angle was considerably below the angle of repose, when friction might have been expected to hold the block after the adhesion ceased. (2) With the larger wedge angles considerable pressure in the bore still compressed the wedge between the cartridge case and the wedge housing with considerable force. Under such circumstances one would expect abrasion of the contact surfaces when movement took place, but no such abrasion was discernable.

"The explanation of these two phenomena apparently

lies in the vibrations set up in the mechanism by the rapidly varying bore pressure.

"The model mechanisms were tested by the Board. One was a crude pistol mechanism having a sliding wedge breech block with a wedge angle of about 16 degrees. The other was an application to the breech mechanism of the Springfield rifle. In this model the wedge angle was about 5¾ degrees. Both mechanisms, so far as the breech closure was concerned, functioned perfectly.

"The rifle mechanism was especially interesting for several reasons, viz: (1) The wedge angle was considerably less than the angle of friction. (2) Sufficient pressure remained in the bore when the wedge opened, for the empty cartridge case to be blown to the rear, carrying the bolt (containing the firing pin and firing spring) before it, with sufficient velocity to cock the firing pin when the bolt brought up against the rear buffer, and causing the empty cartridge case to rebound and to be ejected to the front. This movement of the bolt to the rear was against the force of compression of a spring designed to reload the piece.



"From what has been said it is evident that, in practically every breech mechanism in existence, the force of adhesion must come into play; that there is no tendency for the mechanisms to open under heavy pressure, and that the so-called safety locks or latches serve only to restrain the tendency of these mechanisms to open after the adhesion has ceased."

The Oiling Device

Turning now to consideration of the oiling device in the Submachine gun, and its bearing upon the reliability of operation and the rapidity of fire attained, reference is had to the Springfield Armory report of the functioning test of this weapon, on April 27, 1920. Of the 2000 rounds fired, there was only one malfunction. The first 1000 were fired without mishap. Then the gun was cooled, and the third shot of the second 1000 failed to extract. Thereafter the operation was faultless. In this test, box magazines of 20 rounds capacity were used.

The last 20 rounds were fired in 1 1-5 seconds, which speaks for the rate of fire.

The official report of the Board states that "although the gun was fired as rapidly as magazines could be loaded for each 1000 rounds, the gun did not heat sufficiently to cause trouble, and that the action of the gun appeared strong enough to stand continuous pounding, and functioned reliably during the test."

The perfect smoothness of action made possible by the oiling device explains how a gun, only 22 inches long, and weighing but 7 pounds, could stand under the stress of continuous firing for 28 minutes, 28 4-5 seconds, actual firing time, and elicit the foregoing statement as to its performance.

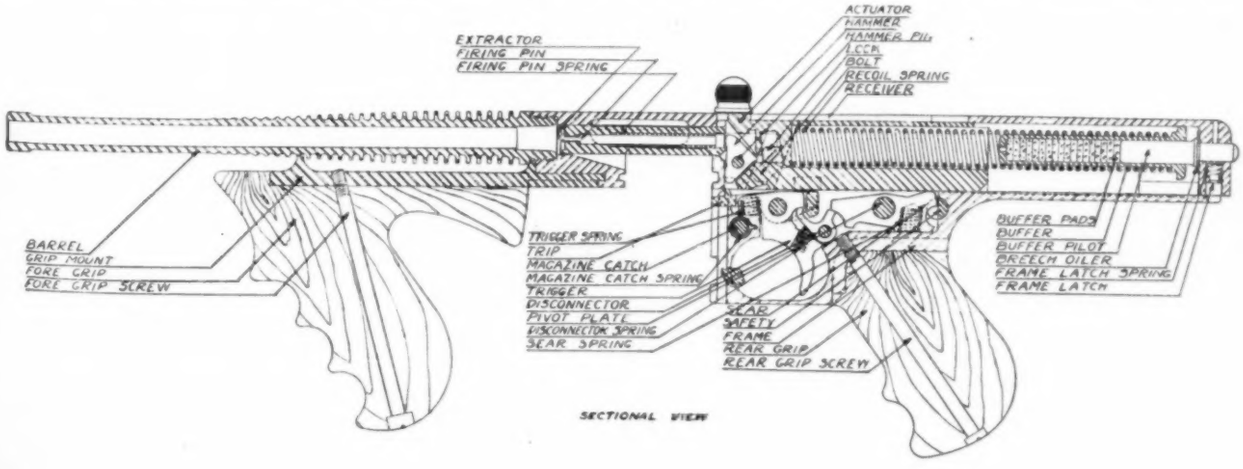
The inventors began by considering the machine gun as a gas engine. Comparing the performance of the best types of machine guns with the most common commercial gas engine, the automobile motor, it was evident that something was missing from the machine gun. Even the most reliable gun could be counted on to malfunction every so often, while the automobile motor was expected to run for considerable periods without stoppage due to mechanical difficulties.

This finally led to a study of the oiling question. It was found that in the operation of automatic arms the friction between the cartridge case and the walls of the firing chamber varied during extraction, and at times was excessive, due to residual pressure of powder gas within the cartridge case. When the friction becomes too excessive either action is stopped abruptly or the cartridge case ruptures, the head being separated from the body.

Friction Trouble Eliminated

This variable friction is attributed to different degrees of annealing the cartridge cases during manufacture, and to tolerances in diametrical or longitudinal dimensions required in the commercial manufacture of cartridges. The important result, however, is that the ejection of the various empty cases takes place at different pressures, and therefore is not at regular intervals, nor with equal ease and rapidity.

From consideration of these factors the inventors decided to build into the Submachine gun the simple oiling device that makes its operation so wonderfully smooth and rapid. With the low pressure ammunition used in this weapon it was found not necessary to oil the cartridges directly, as was done with high power ammunition, so felt



SECTIONAL VIEW

pads were placed in the breech. Enclosed and protected against dirt, the pads are impregnated with lubricant by an ordinary squirt oil can, and each rearward movement of the bolt lubricates the mechanism afresh.

Experiments have shown that it is not necessary to coat a cartridge case with oil to eliminate the friction difficulty in extraction, a very slight smear of lubricant answering the purpose satisfactorily.

Having developed the Submachine gun to this point, the inventors found themselves confronted with the problem of adapting a suitable magazine to the weapon, one that would enable the gun to achieve the maximum possibilities of its novel construction.

The solution to this was found in the Payne drum-shaped or disc magazine, in which the cartridges are fed along a spiral passageway and delivered to the receiver, each cartridge with exactly the same amount of force as every other cartridge in the magazine.

In this uniform delivery of cartridges from the magazine, the Submachine gun derives its last essential requirement.

Disc Magazine Feed

The magazine design is a triumph in its own field, and in operation it lifts 100 cartridges against gravity and feeds them to the gun in such manner that each delivery is perfect in itself, regardless of the number fired or the tremendous rate of fire.

Friction, the bane of inventors of this type of magazine, has been overcome by an ingenious construction with which the cartridges are moved, the actuating principle being a central spiral spring that can be wound with the magazine either loaded or empty.

In the earlier types of drum magazines, particularly those adapted to holding a large number of cartridges, it was found the inertia of the cartridges was so great, and the friction of cartridges rubbing against the walls of the passageway was so high, that the cartridges did not feed freely and uniformly. The pressure of a strong spring propellant, applied to the rearmost cartridge, tended to force the other cartridges outwardly against the magazine walls, in the curved passageway.

When such magazine becomes relatively empty, the propelling force applied to the remaining cartridges is too strong, with the result that these latter, as their number diminishes, are fed out with a force that becomes excessive.

All this is eliminated in the Submachine gun magazine, by means of three special features. One is the spiral passageway for the cartridges. Another is the clockwise movement of cartridges in groups, each by a separate rotor arm, but all impelled by the main motive spring to a point opposite the delivery position. The third important feature is the second motive spring which moves each cartridge in turn into the delivery position, from which it is fed into the chamber of the gun by the action of the bolt.

All these features are secured without sacrificing either simplicity or soundness of construction, as demonstrated by the tests of the Submachine gun.

Method of Employment

The Submachine gun is made without shoulder stock or sights, for ordinary rapid fire from the hip, and can be provided with stock and sights where deliberate aimed fire is desired. It fires full automatically as long as the trigger is held back, but single shots can be fired by quick release of the trigger after each shot.

At the Springfield Armory test, the Board of Officers reported:

"It is thought that the accuracy test clearly demonstrates the claims of the Auto-Ordnance Corporation that a great number of shots could be placed in a reasonably limited sector, provided the bullets could be seen when striking, and corrections made.

"At ranges of 50 to 100 yards the operator directed his fire at will along a row of silhouettes and did not have a dispersion of more than 20 by 18 feet after the first ranging shots which were purposely directed low."

Ballistic tests have shown that the regulation pistol ammunition used will carry about 1400 yards, and is effective at 500 yards. Experimenting with a special powder, the Submachine gun people have obtained an effective range of 800 yards without increasing the charge, and using the same bullet.

At the Armory tests, with the regulation ammunition, the mean of ten rounds taken at 25 feet from the muzzle was a velocity of 878 feet, with extreme variations of 19 feet.

At Quantico the weapon was tried out by the Marines, with great success. Up to 500 yards 95 per cent of hits were obtained, using semi-automatic fire at the rate of 90 rounds per minute. At Camp Perry, Ohio, at the 200-yard range, 20 shots were fired in 10 seconds, semi-automatically, scoring 100 per cent of hits.

Ordnance Technical Notes

The manufacture of an alternate design of trail for the 2.24-inch infantry howitzer carriage, model of 1920, Type I, has been authorized. This trail is so constructed that the rear half can be removed, thus facilitating the use of the carriage in narrow trenches.

There has been prepared and forwarded to the Aberdeen Proving Ground a proof program for the test of the experimental elevating mechanism on the 12-inch mortar carriage, model of 1918. It is expected that this mechanism will enable a saving of 48 seconds to be made in the time required to elevate the mortar from 5 to 65 degrees, with approximately 25 pounds on the elevating handwheel.

A program has been prepared for the preliminary test of 75-mm. pack howitzers, model of 1920 and 1920 MI, their recoil mechanisms, carriages and pack outfits, which test is to be made at the Rock Island Arsenal in the near future.

A program has also been prepared for the preliminary test of 75-mm. guns, model of 1920 and 1920 MI, and the 105-mm. Howitzers, Model of 1920 and 1920 MI, their recoil mechanisms, carriages and mounts, at Rock Island Arsenal.

A report has been received covering a study of the deterioration of copper tubing when subjected to the action of ammonia gas at high temperatures.

Investigations have been made in the Baltimore Office in connection with methods of computing variations in range due to temperature (elasticity) of the air. A discovery has

been made which, it is thought, will greatly simplify the problem of taking account of this variation in the new ballistic tables.

The construction of a combined wheel and caterpillar trailer, Christie type, 3-ton capacity, has been authorized.

The Bureau of Standards is making some progress on magnetic testing of steel. Several new attachments have been tried out and give promise of being useful.

The modification of three Browning aircraft machine guns to operate with electrical synchronizing device, being designed by the Air Service, has been authorized.

Upon the recommendation of the Chief of Infantry, the procurement of a number of new British targets, used at the National Matches in England, for test at Camp Benning has been authorized.

Satisfactory progress is being made on the development of light armor plate. The heat treatment of a series of plates for these tests has been practically completed, and the plates will be ready for test very soon.

Work on the Small Arms Firing Range at Aberdeen Proving Ground, Maryland, is progressing. The roadway has been cut, part of the grading done and a portion of the track laid. The observation towers are under process of construction.

The centrifugal gun, which was designed under the direction of Mr. R. A. Day, New York City, which has been at the Bureau of Standards for some time, has been turned over to the Ordnance Department for test. Test has been held up temporarily pending receipt of ammunition.

A conference has been held to consider standard methods of testing light armor plate. There were present at this conference representatives of the various Manufacturing Divisions of the Ordnance Department, the Navy Department, Frankford Arsenal, and the Technical Staff.

A representative of the Technical Staff was present at the tests of the special light armor plate at Dayton, Ohio, and conferred with the representatives of the Air Service there on the work that is being done by that Service on light armor plate.

The development of a gyroscopic compass for tanks which was suspended pending the results of an investigation of the magnetic compass has again been taken up and the construction of one or more experimental compasses authorized.

The manufacture of six Mark III ruptured cartridge extractors, modified by increasing the strength of the handle and by eliminating the screw driver head, has been recommended in accordance with request from the Infantry Board.

The materials for the investigation of a metal to resist Ammonia-Nitrogen-Hydrogen mixtures at high temperatures and pressures have been received and the preliminary data regarding the physical properties and proper heat treatments for these materials are being worked out.

A program covering the development of chemical warfare materiel to be submitted to the General Staff for approval has been worked up in connection with the Chemical Warfare Service and representatives from the various using services.

The program for firing 12-inch and 14-inch projectiles of new type with powder charges established for the old type heavier projectiles has been commenced. This is for the purpose of determining the muzzle velocity which may be obtained with the lighter weight projectiles using standard powder charges rather than make up special charges for these projectiles.

The modification of a Springfield rifle into a cavalry carbine for test at Fort Riley has been authorized.

A representative of the Technical Staff attended a meeting of the Society of Automotive Engineers' Iron and Steel Standardization Committee in New York.

A representative of the Technical Staff was present at a conference held at the Bureau of Mines by the Presidential Committee on the standardization of oils and greases.

As a result of tests at Camp Benning and Frankford Arsenal, a new type of clip for caliber .30 cartridges has been adopted. This clip was designed by Mr. Ashforth, of Frankford Arsenal, and holds the cartridges more securely than the present service clip.

Representatives of the Artillery Division of the Technical Staff visited the works of the Front Drive Motor Company, Hoboken, New Jersey, and Aberdeen Proving Ground in connection with the forthcoming test of the combined wheel and caterpillar tank now under construction.

A demonstration was held at Aberdeen Proving Ground of Anti-Aircraft machine gun mount, Cygnet type, including trailer; and the anti-aircraft machine gun tripod, Model of 1918; for the benefit of representatives of the Air Service and such other officers in Washington as were interested in these two types of mount.

Mr. Whittet of the Artillery and Automotive Division of the Technical Staff is at Rock Island Arsenal in company with the Chief Draftsman of the Mobile Gun Carriage Section of the Artillery Division for the purpose of acquainting himself with the progress and design of the Pilots under manufacture there.

A program has been started for firing 12-inch projectiles loaded with Explosive "D" against armor plate in order to develop proper methods of loading so that the explosive will not explode due to impact against the plate. Projectiles are loaded with higher density and some in addition to the higher density have a wooden plug surrounded by paraffin in front of the cavity so as to act as a cushion.

A preliminary report on season cracking and physical properties of cartridge brass has been submitted by the University of Michigan. This outlines the line of attack which will be used in the study of the physical properties of cartridge case brass, and also gives the results of a series of tests made to determine the susceptibility of certain small arms cartridge cases to season cracking.

Orientation tables consisting of conversion tables from yards to meters, and from miles to degrees, minutes and seconds, tables of sines and cosines of angles in mils, tangents, and cotangents of angles in mils, logarithms of numbers, logarithms of sines and cosines, of angles in mils, logarithms of tangents and cotangents of angles in mils and the solution of triangles have been prepared in tentative form in the Baltimore office.

Tests of armor piercing projectiles are progressing satisfactorily. The Midvale Steel Company has passed two lots of 14-inch at 25 degrees. The Washington Steel and Ordnance Company has passed a lot of 12-inch at 20 degrees. These were manufactured under an old contract requiring 10 degrees as the minimum. The Bethlehem Steel Company has passed an experimental 14-inch at 20 degrees.

Members watching aerial combat, Friday afternoon

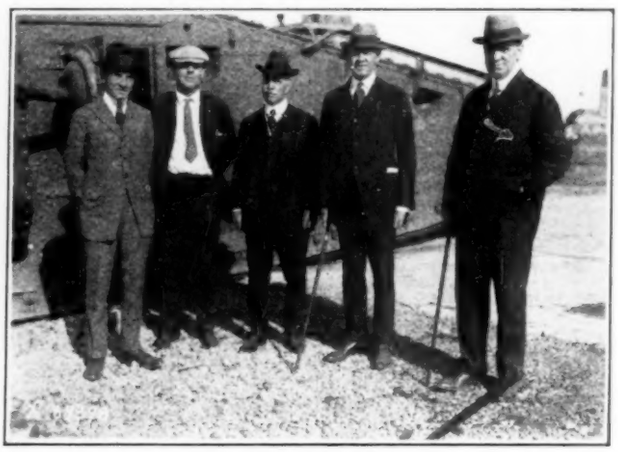
Second Annual Meeting *of the* *Aberdeen Proving Ground*

Mr. CLARKE B. FIRESTONE, writing in the *New York Evening Mail* on October 28, 1920, described the Second Annual Meeting of the ARMY ORDNANCE ASSOCIATION as follows:

At first we stood up. But the turf was dry and warm. So we sat down. Then we leaned back on our elbows. Pretty soon nearly all of us—drab-clad generals, colonels and captains and many-hued civilians—were lying flat on our backs, gazing up at the sky.

Larks and Airplanes.

It looked like a Mexican revolution, but the only posture in which to watch the stars by night or a battle in the sky by day is the recumbent, and we were watching a battle, albeit a mimic one. Meadow larks sang, crickets chirped in the autumn grass, yellow butterflies flitted across the vision, and steadily the two planes climbed toward a great white cloud, each striving to secure a strategic position under the other's tail.



Officers and Directors

Left to right: W. W. Coleman, Vice-President; C. L. Harrison; Waldo C. Bryant; Benedict Crowell, President; Guy E. Tripp

Meanwhile the New York-Washington mail passed overhead, and navy planes from Mitchel Field dropped in on us to tune up, taking position near a Martin bomber which in four hours and thirty-five minutes the day before had come from Dayton, Ohio, to this field on the edge of Chesapeake Bay.

The spectacle, viewed at the horizontal, was a point of rest in the strenuous two-day programme of the Army Ordnance Association at its second annual meeting at the Aberdeen Proving Ground in northern Maryland. What members saw was just the daily routine on the great government reservation, where guns and projectiles receive their final testing, and new designs are fitted into the national scheme of preparedness.

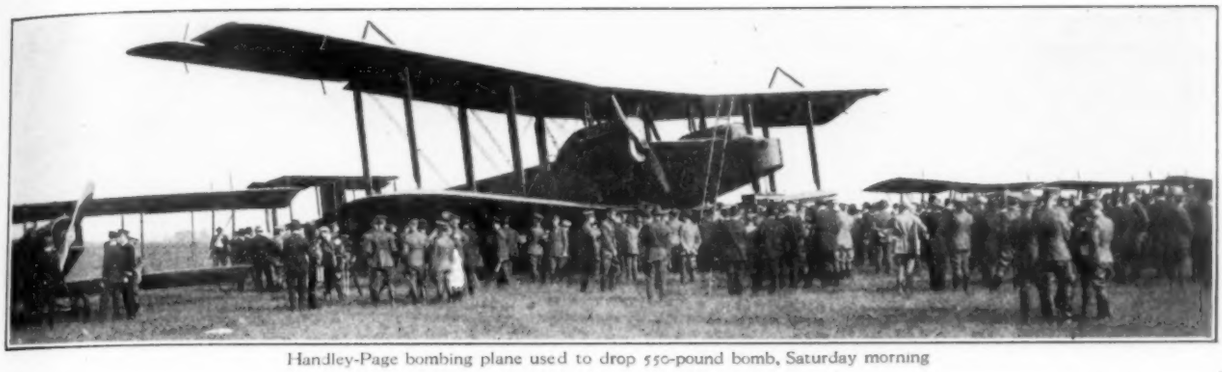
It was a conference horizoned with smoke screens, shaken by the thunder of twelve-inch railway mounts, enlivened by the sharp conversation of the seventy-fives and the chatter of machine guns laying barrages or picking off miniature balloons, dramatized by 500-pound bombs dropped from airplanes at a farm house target, illuminated at night by the intolerable brilliancy of airplane flares floating downward under silk parachutes.

The flight of phosphorus-charged machine gun bullets, visible from start to finish and fired so rapidly that in the distance they looked like a cluster of white California grapes, was an engaging spectacle, and you knew seconds ahead which bullet would turn the balloon into a shred of crimson rubber. There was drama in the firing of the 10 and 12-inch railway mounts, when a rude wind rushed up your trouser legs and the shattering tumult of the explosion was followed by the soaring, steaming, scurrying note of the big projectile as it whined its way below the horizon of silence.

A seventy-five was discharged so rapidly that you saw eight smoke shells in the air at one time. But the last word in speed was spoken by the centrifugal gun, used by no country in the World War and still in the experimental stage, yet already firing 1,200 bullets a minute. Bullets is not quite the word. A leaden bullet would have been reduced to paint in that drum, revolving 10,000 times a minute, and they used tempered steel ball bearings instead.

Back to the Sling.

The centrifugal gun is the sling which David swung round his head when he toppled over Goliath, but reduced to cylinder form and operated like a hydraulic turbine with a motor attached. It dispenses with explosives—good-by to gunpowder! In a minute it made a big target look like a sieve. It is intended for tanks, for landing



Handley-Page bombing plane used to drop 550-pound bomb, Saturday morning

Army Ordnance Association

October 22-23, 1920

parties, for front line trenches. Its present range will need to be extended.

It is a fair guess from the spectacles of Aberdeen that the caterpillar self-propelled tractor, mounting a big gun on its own platform, offers better prospects for service than the gun on its own wheels, but hauled by another tractor. This late development of the World War commanded the admiration of the manufacturers whose presence at the conference attested at once their war service as munition makers and their purpose to keep in touch with the Ordnance Department for the preparedness of the future.

The *New York Sunday Herald* of November 7, 1920, refers to the Second Annual Meeting under the heading

NEW ORDNANCE MARVELS ATTEST UNCLE SAM'S AWAKENING!

Civilian Experts Give Their Services and Technical Schools Co-operate with Government Engineers to Build Up Vital Branch of Defensive Forces.

Centrifugal machine gun being demonstrated by its inventor

"There was one great lesson which the United States learned from the great war. That lesson was that armies may be improvised and trained quickly, but the creation of material requires time. Not only was it learned that time is required to perfect materiel, but preliminary training is the necessary accompaniment of the production of the machinery of war. . . .

"The lesson has been taken to heart, and every effort of the War Department is now being expended to build up materiel, and it is being assisted by some of the leading industrial spirits of the country, who are keeping up the same enthusiastic devotion to the service of their country they displayed in the war.

"A little army of dollar-a-year men, headed by Benedict Crowell, former Assistant Secretary of War, has mobilized itself under the name of Army Ordnance Association and is giving its valuable time to the country without costing the Government a single cent.

"Results are already beginning to show from this combined civilian and army effort. New and effective pieces of ordnance are being produced, many of which would have been tremendously effective on the firing line in Europe. They were tried out at the Aberdeen (Md.) Proving Grounds last week under dramatic circumstances. . . .

"The accomplishments so far attained are comparatively few in number, the Government not having reached the point where it feels justified in building up a large supply of ordnance materiel. What is now being done is to perfect types which will furnish model and inspiration for future development. The object of greater mobility in manœuvring is being attained to a highly gratifying degree. Guns are being perfected upon movable carriages in a manner that will revolutionize artillery practice of the future. . .

"After the Armistice was signed the army took stock of the reasons why it was not able to prepare and transport ordnance to the front. The conclusion reached was that American industry was not trained for the building of ordnance, with the result that army officers indulged in the one sentiment that the country must never be caught in the same predicament.

"It was at this point that the civilian group organized the Army Ordnance Association. The first president is Benedict Crowell. The other members (Board of Directors) are William Wheeler Coleman, president of the Bucyrus Company of South Milwaukee, Wis.; Charles Elliot Warren, past president of the American Bankers Association; Ralph Crews, of the law firm of Shearman & Sterling, New York City; Guy Eastman Tripp, chairman of the Board of Directors of the Westinghouse Company; Samuel McRoberts, of the National City Bank of New York; Waldo Calvin Bryant, president of the Bryant Elec-

Field battery putting down smoke screen barrage

12-inch gun being fired from special all-round fire railway mount

tric Company; Frank Augustus Scott, former chairman of the War Industries Board; Robert P. Lamont, president of the American Steel Foundries of Chicago, and C. L. Harrison of the First National Bank of Cincinnati.

"The first idea of this civilian group, whose proffer of assistance was accepted by the War Department, was to build up a civilian reserve. It was proposed to interest the schools and colleges of the country and wherever possible courses in ordnance and in the science of ballistics have been installed. The plan provides that students in colleges and universities may find proper mental training and a proper application of their mathematical knowledge in studying ballistics. These students are listed so that in the event of war the Government will know where to reach out for them and apply the training they have received.

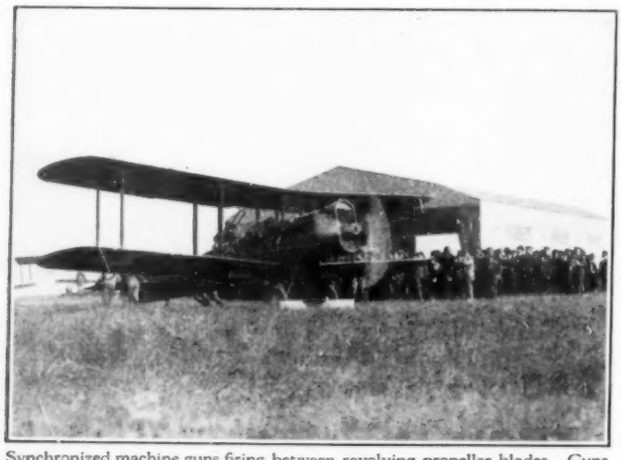
"In its attempt to build up ordnance during the war great effort was spent in building the proper machinery. Much of this machinery, including special lathes for the purpose of turning out shells and cannon, has been distributed among the scientific schools of the nation, like the Boston School of Technology, where the students are trained how to use it. The various manufacturers of the country have also been enlisted in this programme of preparedness, which is without parallel in the history of this country.

"In the experience at the Aberdeen Proving Ground the object of increased mobility of heavy ordnance was highly exemplified. In one case the Ordnance Department has developed a sixteen-inch* gun mounted on a railway carriage in such a manner that the gun can be elevated almost perpendicularly. This gives the weapon the advantage of the howitzer. During the war it was possible to direct these guns only in one direction. The American gun is mounted on two cars with a bridge between. A circular turntable track is built beneath the bridge so that the gun carriage can be turned and the gun pointed in every possible direction.

"The Ordnance Department has also developed a combined wheel and caterpillar mount for heavy and light artillery. Tanks are equipped in the same manner. This invention makes it possible when running on smooth roads to fold back the caterpillar traction so that the tank can run on wheels, giving it the speed of an ordinary automobile. When approaching rough ground the caterpillar traction is quickly readjusted so the machine can negotiate any kind of rough going.

"The mounting of heavy guns in this manner on their own self-propelled mounts is of the highest military importance. Military science has so far developed that the location of a gun can be determined by instruments prepared to catch the sound waves. The result was that during the war heavy guns soon after taking up their positions would be located by the enemy and destroyed by counter artillery fire.

"With the new movable carriages propelled by gasoline power these guns can be moved about after firing a few shots. The result is that shells dropped on the position



Synchronized machine guns firing between revolving propeller blades. Guns on flexible mount firing over upper plane

Christie Tank surmounting obstacles by caterpillar traction. The caterpillar tread is removable, permitting wheeled traction on good roads at the speed of an ordinary motor truck.

Air craft artillery. 37-mm. automatic cannon mounted in Liberty Motor to fire through the propeller shaft of aeroplane

Firing anti-aircraft machine guns at free balloons

located by sound waves will have nothing but empty space to deal with.

"The tanks equipped with a combined wheel and caterpillar traction have solved the question of mobility so far as that weapon is concerned, and have increased the effectiveness of the tank a hundredfold.

"The artillery periscope is another war device whose high development was shown at the Aberdeen experiments. This mechanism makes it possible for the observer to remain in his dugout underneath the ground and inspect terrain with all the advantages of high elevation.

"Other arms of the ordnance service have been developed concerning which considerable secrecy is being observed.

"The Ordnance Department is now conducting intensely interesting experiments in the development of higher grades of powder than were ever used. Smokeless powder now makes it impossible to observe the discharge of artillery in the daylight. Government and private chemists are now working in an effort to develop a flashless powder which will make the discharge of artillery non-observable at night.

"The whole scheme and purpose of the experiments that are being conducted is to build up the highest possible form of weapons of war. Back of that is the mobilization of highly trained persons in the technique of artillery practice and the plan to mobilize the industrial interests of the country from manager down to the humblest workman so that at a moment's notice and at a given word the whole country can be turned into a plant for the manufacture of all forms of army ordnance.

"It is the purpose of these patriotic individuals in the army and out of it to see to it that this country will never again be caught in the helpless position in which it found itself at the outbreak of the World War because of the lack of preparedness for just such a calamity."

*[Twelve.—Ed.]

The Sale of "Old Hickory"

The Nashville Industrial Corporation, of Nashville, Tenn., has purchased the world's greatest industrial centre—the "Old Hickory" Powder Plant at Jacksonville, Tenn.

The War Department's total monetary recovery from the great plant is approximately $9,400,000.00. This is composed of individual sales and transfers to other Government Departments of approximately $5,890,000.00, and the sale to The Nashville Industrial Corporation of $3,505,000.00. In addition to the monetary consideration in the transaction, the War Department reserves a large amount of space at the plant for the storage of ordnance, sodium nitrate, powder making machinery, and other materials. This alone is worth several hundred thousand dollars a year to the Government, and saves the expense of moving to various arsenals the war reserves located at this point.

The Nashville Industrial Corporation is composed of business men of Nashville, Tenn., only 12 miles distant from "Old Hickory," on the navigable Cumberland River. The purpose of the Nashville people is to industrially develop this immense war undertaking into a large manufacturing center, having available immense housing and manufacturing buildings and facilities. The village had a population of 35,000 when the plant was closed in 1918, and is now completely equipped with all necessary public utilities, schools, banks, etc., and offers many attractive inducements to new industries or those desiring a change of location.

This was the largest government manufacturing undertaking during the war. It occupies 5,100 acres of land, has a water filtration system capable of supplying a city the size of Boston; one of the largest steam power plants in the world, a double track railroad connecting with trunk lines, 35 miles of industrial track connecting manufacturing buildings, an immense refrigeration system, complete water works, sewerage system, fire departments, concrete and macadam roads.

Arrangements have already been made to operate certain portions of the chemical units, and it is expected that within 90 days parts of the various plants will be producing. However, the plant is so large and has so many duplicate units that a part of the equipment must be sold. The release of this vast quantity of chemical equipment will prove a boon to the American chemical industry which is now suffering from a shortage in the equipment market.

By this sale the manufacturing interests of the nation also are saved housing costing more than $12,000,000.00, as a sale to a wrecking concern would mean the destruction to this modern industrial city. It also means that the boiler house and the water purification plant, and the foundations of a smokeless powder plant will remain intact. The two former plants will be kept in operation by the purchasers.

ARMY ORDNANCE

VOL. I. NOVEMBER-DECEMBER, 1920. No. 3

The Year Ahead!

DURING the past fifteen months the Army Ordnance Association has frankly been in a formative stage, but that time has been sufficient to develop three principal activities, which can be summed up in the phrases:

(a) To Conserve Ordnance Knowledge;
(b) To Extend Ordnance Knowledge;
(c) To Disseminate Ordnance Knowledge.

The first of these activities was naturally the one to which the Association gave its immediate attention. As a result there is in existence today a card index giving names, addresses and business connections of some 14,000 individuals who are considered to have acquired knowledge of the design and manufacture of Ordnance to an extent rendering them valuable military assets to the nation in connection with the munition program of any future emergency.

Until very recently, it has not been the policy of the United States to encourage private initiative in the design and manufacture of Ordnance, a handicap which manifested itself to our great disadvantage when we embarked upon the World War. Happily, there is at present evidence of a real desire upon the part of American Industry to give thought in time of peace to the problems which it will be called upon to solve in time of war. Moreover, the Ordnance Department has adopted a most praiseworthy attitude in welcoming efforts of industry to prepare itself for its war task. Technical colleges have been assigned problems in research connected with the improvement of Ordnance materiel, private corporations have been given the task of *designing* as well as manufacturing Ordnance, the great engineering societies have been invited to participate in the preliminary discussion and criticism of designs for new types of Ordnance, all to the end that a larger proportion of the civilian population of the country may interest itself in Ordnance in line with the second objective of the Army Ordnance Association—"To Extend Ordnance Knowledge."

In addition to preserving the Ordnance knowledge acquired during the World War, and extending the field of personnel actively interested in the investigation of Ordnance problems, it is necessary to disseminate the fruits of these researches to the widest possible extent. This the Association is endeavoring to accomplish by publishing an official Journal, outlining recent Ordnance developments to the end that a great number of persons may have some conception of the status of our mechanical defenses, and thereby render the Ordnance knowledge available to the War Department on the outbreak of war in some degree commensurate with the enormity of the problem which must be faced.

With these several activities under way on what is as yet a small scale, there remains the duty of increasing the effectiveness of each by increasing the number of persons who understand the importance of these several tasks. This can be accomplished most easily and quickly by increasing the membership of the Association. On September 30, 1919, the membership of the Army Ordnance Association numbered 859. One year later it had reached 2,500, or an increase during the first fiscal year of 191 per cent. This rate of increase must be kept up or exceeded during the coming year if the Association is to take the place in national affairs to which the importance of the subject entitles it.

A corrollary to these three major activities and exceeded in importance by none of them, is the necessity for creating and maintaining harmonious relations between the Government and the civilian manufacturers to whom it will inevitably turn for assistance in any future emergency. The Association can render no greater service to the Government and to Industry, which means to our country, than to accept as a definite task the threshing out of disputed points of controversy which arose during the recent emergency, and which will, of course, arise again unless steps are now taken in the light of our most recent experience to adjust them equitably to all concerned. In this number appears physical evidence of the first concrete step taken toward this end—Major Galleher's proposed form of standardized Government contract. Discussion of this question in the columns of ARMY ORDNANCE will further improve the conditions which Major Galleher has described and which he seeks to correct. The amount of time and space which can be devoted to this worthy object are, however, dependent upon funds available after the necessary administrative expenses of the Association and the cost of publishing its Journal have been paid. The work will proceed in exact ratio with an increase in the membership of the Association, and every member is urged to assist even thus indirectly in solving the first concrete problem attacked by the Association—one which it hopes to make part of its record of accomplishment for the ensuing year.

Maximum Nitrogen Preparedness at Minimum Cost

FIXED nitrogen in usable form is indispensable to the future of America either at peace or at war. During peace it is needed in ever-increasing quantities in agriculture and in the chemical industries; during war these needs are greatly increased by the demands for military powder and explosives. The Army is becoming more and more dependent upon chemical munitions for its effectiveness, and this dependence will increase as time goes on. We are at present more than 50 per cent dependent upon importation of nitrogen for peace purposes, and the future will increase this dependence if proper steps are not taken to correct the situation. Additional requirements for war purposes would, of course, greatly increase this dependence.

Improvement of this condition, both for peace and war, seems to be dependent upon our ability to accomplish the fixation of atmospheric nitrogen. This solution requires not only up-to-date knowledge of methods used in fixing nitrogen and in converting it into forms available for military, agricultural, and industrial purposes, but it requires an operating organization and a going plant capable of expansion in time of need. At present, we have in the United States neither the complete knowledge required nor an operating organization and a going plant for fixing nitrogen and making it available to the military program. Furthermore, there is no immediate prospect of attaining these ends through private industry or capital. The nitrogen problem must therefore be tackled by the government itself and *at once*, since from a military standpoint its satisfactory solution is quite as vital as the maintaining of the Army itself.

Fortunately, as a result of the National Defense Act of

1916 and of war developments, we have made a great start in nitrogen preparedness. We possess the No. 1 nitrate plant for fixing nitrogen by the Haber process. As yet it has not proven entirely successful, but this method has been used successfully in Germany, and there is no doubt that further research and development in this country will make No. 1 into a satisfactory plant. We also possess the No. 2 nitrate plant, which a test run has proven to be thoroughly satisfactory and able to fix some 40,000 to 45,000 tons of nitrogen per year, or the demand of approximately 14 divisions. We are building a hydro-electric plant on the Tennessee River, which, in conjunction with the steam power already installed, will not only meet the needs of the plants but will give a surplus available for expansion or for other purposes.

But this start, great as it is, will be of little value unless it is carried to its logical conclusion. The work at the No. 1 plant, costing some $13,000,000, will have been in great measure lost unless it is properly developed. The No. 2 plant, costing some $70,000,000, will deteriorate and become obsolescent in a relatively short time unless it is kept in operation, and will have as a consequence greatly reduced military value. Fortunately, *these nitrate plants have a peace as well as a war-time value.* Studies of peace-time demand and supply of nitrogen indicate that the market can absorb the products of these plants without curtailing the logical expansion of other sources of nitrogen. The No. 2 plant, in conjunction with the hydro-electric power being developed, can produce its peace-time products at a price satisfactory to both the government and the consumer.

The Wadsworth-Kahn Bill, printed elsewhere in this issue, is the result of a great deal of study, thought, and effort on the part of representatives of the War Department, among whom were experienced business men. It asks no new appropriation, for the reason that operation and development of nitrogen fixation plants under Government control justifies the sale of sufficient war reserve sodium nitrate stocks to raise the necessary capital to finance the undertaking. Inasmuch as during peace times the work would be almost wholly commercial, the bill provides for the formation of a corporation along business lines in order to gain the advantages thereof. But in order to insure that the public interests are properly provided for, the control of the officers of the corporation is placed under a responsible Government official—the Secretary of War—and a detailed statement of the fiscal operations of the corporation is to be submitted to Congress every year. It gives to the United States an operating organization and a going plant engaged in fixing nitrogen and making it available for both peace and war. It allows the continuance of research development on a proper scale to help solve the problems pertaining thereto, which are of national importance. It provides for a means of operating our holdings on a self-sustaining basis.

In short, the Wadsworth-Kahn Bill, if passed by Congress, will give to the United States maximum nitrogen preparedness at minimum cost.

War Insurance—the Ounce of Prevention

IT would seem that, as a nation of thinking human beings, with an average of education by no means low, the World War should have taught us at least one unforgetable lesson. That is that pretty nearly *anything* can overtake us, as individuals, or as that grouping of individuals we call a nation, if we are not in some way prepared to meet it. The only excuse for allowing oneself to be overtaken, all unprepared, by an avoidable misfortune, is ignorance of how to avert or overcome that misfortune. There is no excuse for making the same mistake twice. Presumably man learns by experience, and a man—or a nation—who fails to learn well by one experience has usually to learn his lesson twice. It may well be that he learns the second time at infinitely greater cost.

Against all other forms of disaster which have visited themselves upon mankind, we take measures to protect ourselves. After stamping out one epidemic of smallpox, the physicians of the country do not immediately stop practicing medicine on the somewhat unstable assumption that there will never be any more sickness; they do not burn nor throw away their medical books and then announce with bland assurance that two smallpox scares seldom occur within the same generation. Aside from this somewhat summary method of dismissing future generations to shift for themselves, we would consider such criminal waste of valuable knowledge as a species of insanity.

Smallpox is not so frightful in itself, nor in its consequences as war—yet we find many otherwise keen intelligences singularly indifferent to the possibility of its recurrence at some future time. Allowing the knowledge gained during the last outbreak of the war plague to lapse is no more sane than to advocate the retirement of all our doctors to the golf-links and diverting all our pharmacists to the selling of perfume and scented soap. The golf stick is a more joyous implement than the scalpel, and toilet water smells better than formaldehyde, but there can scarcely be any question as to which has proved more beneficial to humanity in a crisis. With all due respect to our natural desire to cast our lot in pleasant places and forget disagreeable possibilities as fast as we can, there yet remains stern reality to be reckoned with.

It is not sufficient to simply announce that there are going to be no more wars. We hope not. As individuals, who have perhaps suffered personal sorrow that nothing can assuage; as Americans who, so far, have fought only for freedom from one sort of injustice or another, we will do everything in our power to free ourselves from the menace of future wars. But we can no more state, with any degree of positive assurance, that there will be no more wars than we can state that there will be no more fires.

Suppose a man loses a great many valuable possessions in a fire and has no insurance to cover that loss—what does he immediately do to avoid a repetition of his misfortune?

In addition to taking the utmost precaution to avoid the danger of future fires, does he not take out a fire insurance to protect what remains to him, together with such new possessions as he may once more accumulate? Because he has been through one fire is certainly no guarantee that, through catastrophe over which he has no control or events he could not foresee, he will not have another fire. But he can also certainly be prepared to meet that disaster in such a manner that it can be overcome with the least possible loss or damage.

Surely a nation which is so professedly peace-loving, which reacts from the horror of war as this nation has reacted, should take protective measures against future wars. It should take out some sort of War Insurance.

We should fight war as we fight fire, with every means we can find to exterminate the deadliest menace to life, liberty and the pursuit of happiness that the world has known. Insofar as it is possible, we must make our building fire-proof, and keep within reach the means of quenching the destroying flame should it come creeping about us again. Let us not, therefore, go about our peaceful pleasures quite secure in the unfounded conviction that nothing will ever again catch fire—even now children within

may be playing with matches, there may be a careless servant, or sometime again a neighborhood brawl which will ignite a tremendous amount of trouble for us all.

It is not enlightenment but lethargy to declare that there is no need for preparedness. Doubtless most civilized men today would be glad to see an equitable adjustment of things so that it would never be necessary to pit force against force, but it has been demonstrated before our eyes within the last few years that mankind has a long way to go before his problems are all worked out amicably and entirely without danger of might being proved to be right. How many of us believed that so soul-searching an experience as a world at war must result in great changes for the better in the lives and conduct of civilized nations. But perhaps the only point made by those years of bloodshed is that it will take more than a mere war or two to radically affect human nature. Evolution is a slow process, and education, which is evolution's method of speeding up mental development, cannot be accomplished in a day. Whatever we may hope, we have not ideals to deal with today but facts. And the facts in the case are that because we have been through the scorching flames three times within the memory of living men we yet have no reason to believe that we are forever immune from similar calamity. It behooves us to keep the Fire Department skilled and alert, the fire-fighting instruments ample to meet any emergency, and until the world has accomplished the slow, almost invisible changes that occur, changing monkey to man and man perhaps to superman, to keep ourselves ever ready to profit by the lessons within our ken and to avoid recurrence of past mistakes by just the ounce of prevention that might have saved such untold human suffering.

Addresses of A. O. A. members wanted

Letters on Association business sent to members at the addresses given herewith were returned by the Postal Authorities for better address. If any one knowing the correct address of any of the following will communicate with the Secretary at 410 Munsey Building, Washington, D. C., it will be appreciated:

Mr. Wm. B. Adams, care A. W. Willcuts, 351 Dexter Bldv., Detroit, Mich.

Mr. Frank Howard Beall, The Woodley Apt. 102, Washington, D. C.

Capt. Francis M. Clark, 2660 Woodley Road, Washington, D. C.

Mr. A. B. Dunn, Supt. New Castle Plant, Bethlehem Loading Co., River Road, New Castle, Del.

Mr. Earle A. Jones, 1324 Euclid St., N. W., Apt. No. 44, Washington, D. C.

Mr. Harry Franklin Meiling, Hotel Tuller, Detroit, Mich.

Mr. Chas. Prendergast, Gen. Supt., Briscoe Motor Corp., Jackson, Mich.

Mr. H. G. Robinson, 12 Carver Road, Watertown, Mass.

Mr. John V. Schafer, Caskey-Dupree Mfg. Co., 408 Scammel St., Marietta, Ohio.

Mr. Jacob Schorr, Greenwald Bros., Inc., 9th and Spruce Sts., Philadelphia, Pa.

Lt. Charles W. Tholen, Minneapolis, Minn.

Mr. A. Mitchell Todd, 2639 S. Felton St., Philadelphia, Pa.

Capt. Theron H. Walker, 2905 Leeward Ave., Los Angeles, Cal.

Capt. Wells B. Williams, 1819 W. 39th St., Chicago, Ill.

Lt. Frank J. Yuhse, Fed. Motor Truck Co., Detroit, Mich.

Most of the members of the Technical Staff visited Aberdeen Proving Ground on the occasion of the meeting of the Army Ordnance Association for the purpose essentially of witnessing the demonstration. Attention was particularly addressed to the pivot mounting for the Batignolle Railway Mount, 75-mm. self-propelled Mount, the Christie Pilot Tank, the Reconnaissance Tractor, Power Cart, Hand Cart, and the White Staff Car equipped with experimental caterpillar traction.

Progress in Organization, A. O. A.

In considering possible types of organization for the newly-formed Army Ordnance Association, the Committee on Aims and Organization was under the necessity of devising a form of organization which would lend itself readily to enlisting the active and continuing interest of individual members, and yet was faced with the fact that the general subject of Ordnance was entirely too broad to be grasped by anyone not devoting his entire time to it.

Under these circumstances, it was decided to group the entire membership within divisions along "subjective" lines, that is, under the several main items in the list of Ordnance matériel with an additional division to comprise members interested in the various Ordnance Field Service activities. In this manner, it was hoped that members particularly interested in Small Arms, for instance, would be kept informed by the Small Arms Division of the Office of the Chief of Ordnance concerning recent developments along the lines of their mutual interest, and similarly for the other divisions.

To accomplish this, it would, of course, be necessary to send to each member a questionnaire and to compile rosters from the replies thereto. In spite of the considerable expense involved, this would have been done except that the proposal to have the Association issue an official Journal was advanced and later approved. Due to the high cost of publishing a magazine of the general make-up of ARMY ORDNANCE, the Association will not be in a position to assume the administrative expense of compiling and keeping up-to-date rosters of divisional memberships until a considerable increase in membership reduces the percentage of overhead expense. However, in view of the desirability of the subjective divisional form of organization, it is believed wise to work toward this end in order the more readily to organize the subjective divisions when funds become available for efficient operation.

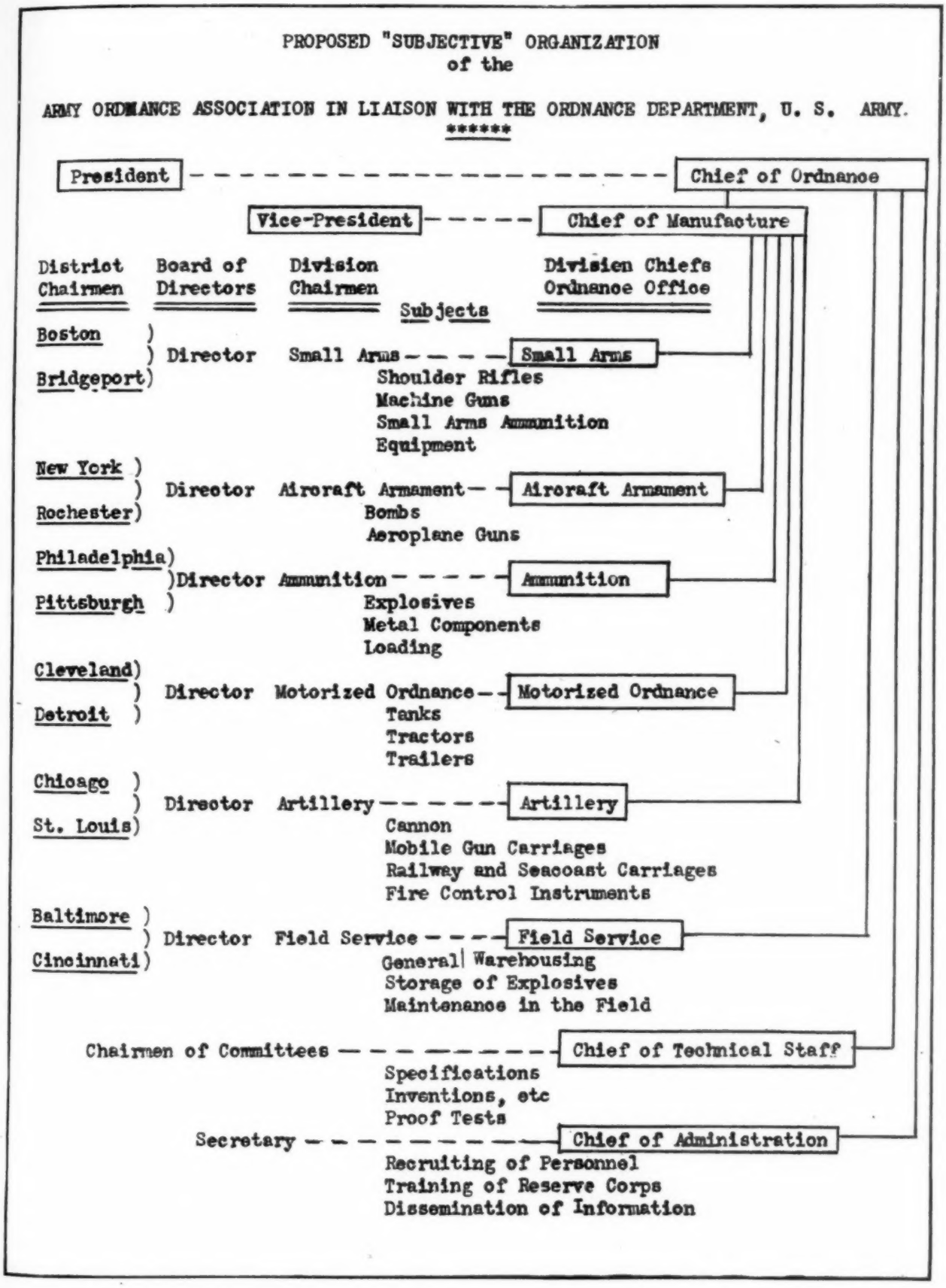
Accordingly, beginning with this issue, several of the divisions of the Ordnance Office will contribute short articles concerning their most recent activities, grouped under a standing heading which will be repeated from issue to issue.

In order to carry this idea more completely into effect, each of the six bi-monthly numbers of ARMY ORDNANCE will be assigned to a division of the Ordnance Office as the particular number in which they can have full rein to state their problems and outline ways in which the Association can be of assistance in their solution. The first of these special numbers will be the Ordnance Field Service number, January-February, 1921.

The chart on the opposite page is intended to show diagrammatically the inter-relation of the officers and units of the Association with the Chief of Ordnance and the several divisions of his office. The chart does not pretend to outline a perfect organization for the Association, but does indicate one which will lend itself to enlisting the individual interest of members in the particular phases of the general subject of Ordnance which most appeal to them. The President of the Association will naturally be concerned with the broadest problems arising in Ordnance design and manufacture and is, under the By-laws of the Association, instructed to "consult frequently with the Chief of Ordnance or such other officer of the Army Ordnance Department as may be placed by the Chief of Ordnance in charge of the industrial mobilization of the country for the manufacture of Ordnance." He is also assigned to the supervision of District activities, Districts of the Association conforming to the industrial districts organized for the production of Ordnance during the World War.

In order to reduce the governing body of the Association to workable proportions, these 12 districts have been grouped in pairs according to contiguity and the Nominating Committee has selected directors to represent each of these six pairs of districts on the Board of Directors, each director being also assigned to supervision of one of the six divisions of the Association. For instance, the Boston and Bridgeport Districts are jointly represented by a director who is also assigned to supervision of Small Arms activities. This arrangement insures that every district of the Association is represented on the Board of Directors as well as every divisional activity.

Under the By-laws, the organization of the districts and divisions of the Association is permissive rather than mandatory, but steps have been taken during the past year in all of the districts except three to form District Membership Committees. Divisions of the Association will be formed as soon as practicable, temporary chairmen being appointed by the Board of Directors as provided in the By-Laws. These Division Chairmen under the supervision of the Vice-President will co-operate with Division Chiefs of the Ordnance Office in the solution of problems arising in connection with the design and manufacture of articles of Ordnance in which they are mutually interested.


PROPOSED "SUBJECTIVE" ORGANIZATION
of the
ARMY ORDNANCE ASSOCIATION IN LIAISON WITH THE ORDNANCE DEPARTMENT, U. S. ARMY.
*****
President
Chief of Ordnance
Vice-President
Chief of Manufacture
District Chairmen
Board of Directors
Division Chairmen
Subjects
Division Chiefs Ordnance Office
Boston
Bridgeport
Director
Small Arms
Small Arms
Shoulder Rifles
Machine Guns
Small Arms Ammunition
Equipment
New York
Rochester
Director
Aircraft Armament
Aircraft Armament
Bombs
Aeroplane Guns
Philadelphia
Pittsburgh
Director
Ammunition
Ammunition
Explosives
Metal Components
Loading
Cleveland
Detroit
Director
Motorized Ordnance
Motorized Ordnance
Tanks
Tractors
Trailers
Chicago
St. Louis
Director
Artillery
Artillery
Cannon
Mobile Gun Carriages
Railway and Seacoast Carriages
Fire Control Instruments
Baltimore
Cincinnati
Director
Field Service
Field Service
General Warehousing
Storage of Explosives
Maintenance in the Field
Chairmen of Committees
Chief of Technical Staff
Specifications
Inventions, etc
Proof Tests
Secretary
Chief of Administration
Recruiting of Personnel
Training of Reserve Corps
Dissemination of Information

Organization. The Artillery Division is a part of the Office of the Chief of Manufacture and is responsible for the development, design, procurement, production and inspection of artillery materiel. Artillery materiel includes all guns and trench mortars with their mounts, and fire control instruments for all calibers from the infantry accompanying howitzer to the largest. The types of materiel include accompanying, mountain, field, siege, self-propelled, anti-aircraft, railway and seacoast.

The present Chief of the Division is Maj. G. F. Jenks. The division is divided into the following sections: The Mobile Carriage under Maj. J. B. Rose, the Seacoast and Railway Carriage under Maj. G. M. Barnes, the Caterpillar Mount under Maj. B. O. Lewis, the Cannon under Maj. K. F. Adamson. Maj. A. E. Guy is assigned to special research work, and Captains Ira Crump and W. F. Vander Hyden and Lt. J. M. Erwin are student officers in the division. The Fire Control Section was transferred to Frankford Arsenal and is now engaged in the development and design of fire control instruments under Maj. H. K. Rutherford.

The Rock Island, Watertown and Watervliet Arsenals are under the control of the division. The Erie Howitzer Plant and the Rochester Gun Plant, maintained under the administration of Watervliet Arsenal, are also included in the division facilities. Fire control is produced at Frankford Arsenal.

Production Facilities. As a result of studies made after the armistice, it was decided that the Department should retain at the Arsenals, production capacities only for such materiel as could not be procured from commercial plants in time of war without serious delay. Manufacturing capacity was held for guns and recuperators. These articles require special shop buildings, equipment and machine tools. Gun carriages, except for the recuperator, can be produced in automobile or car plants and no war capacity for such articles has been held. The Department's facilities for gun forgings have not been greatly increased as commercial plants are now available or could be modified for gun forging production within a reasonable time. Jigs, fixtures, gauges and special facilities, constructed during the war for manufacture of special articles, have been shipped to the arsenals and classified for future use. Studies have been made and are still progressing of the methods of manufacture used by contractors during the war. These data will be collected and made available for the future contractor.

For war production and peace time manufacture, the machine tool equipment has been carefully renewed at each arsenal. The Department now has available some of the best equipped plants in the country. Watertown Arsenal is equipped with an open hearth and electric steel foundry, a gun forge plant, a projectile plant, and shops for the manufacture of seacoast and railway mounts. It has production capacity for cradles and recuperators for guns of 8-inch caliber and above. Watervliet Arsenal and its outlying plants have production capacity for all calibers of guns from 75-mm. up. Rock Island, in addition to its machine guns and small arms plants, has production plants for recuperators for field and siege guns and well equipped shops for peace-time manufacture of gun carriages and tractor materiel.

At present the Department has no artillery in process except that for the armament of seacoast defenses, including railway mounts.

Development. During May, 1919, the Westervelt Board, after a study of the artillery used during the World War, made its recommendations for a program of artillery development. This program calls for the redesign of every type and caliber of artillery used during the World War. The Artillery Division has been engaged on this program during the past year and a half. It has brought out new designs of all calibers covered by that report except fo the 240-mm. howitzer and the 8-inch gun. For example, it has developed three types of guns and four types of carriages for the field gun. The carriages include a split trail wheel type, a box trail wheel type, a Holt self-propelled caterpillar type, and a Christie self-propelled type. In general, developments of all caliber mounts include the wheel, the Holt caterpillar self-propelled and the Christie self-propelled types. Developments of railway mounts include the type which has 360 degrees traverse between the gun mount and the car body and the type in which the car body traverses on tracks prepared on the ground. The first mentioned type is suitable for 12-inch howitzers or smaller calibers, and the second type for 14-inch guns and 16-inch howitzers.

The range requirements of the Westervelt Board program necessitate longer guns of minimum weight. To meet these requirements gun development has proceeded along three parallel lines. The necessary strength and lightness is being secured, first, by the use of alloy steel of higher physical quality than previously prescribed; second, by the use of wire wound construction and, third, by the autofrettage construction.

The fire control methods for anti-aireraft artillery have never been satisfactory. The problems awaiting solution are complex and difficult. The enormous extension of range of our seacoast cannon attained by mounting 16-inch, 50 caliber guns to be fired at elevations corresponding to maximum range, requires the development of instruments for balloon and aireraft observation.

All of these problems have opened up new engineering questions which demand answer before the main problem can be solved. Many questions can be answered in the foundry, and the forge and machine shops. Many require investigation which only the Research Laboratory is capable of conducting.

That these problems are being solved is evidenced by

the fact that the following pilot materiels for proving ground tests are completed or being assembled:

1.8-inch infantry accompaning howitzer,
75-mm. pack howitzer,
75-mm. gun on split trail wheel mount,
75-mm. gun on Holt caterpillar self-propelled mount,
75-mm. gun on Christie self-propelled mount,
105-mm. howitzer on split trail wheel mount, and
12-inch howitzer on railway mount.

A large program of other pilot materiel is under manufacture.

In addition to Westervelt Board projects, the division has brought out new designs of barbette carriages for 16-inch, 50-caliber guns and 16-inch, 25-caliber howitzers. The first of each of these materiels is nearing completion and will soon be ready for proving ground tests.

It is not anticipated that the models of artillery now under development are going to be satisfactory either to the Ordnance engineer or to the Service. They, however, embody in concrete form, the experience of the World War. Refinement of design and reconstructing will be necessary. They are the first steps in the realization of the dreams of the artilleryman for an ideal weapon.

Artillery Wheels. It is not intended in the brief space of this article to attempt any thorough discussion of the title, as casual knowledge will tell one that the answer depends on consideration of numerous conditions of manufacture and use. The question is, however, at this time one of concern to the Artillery Division.

Prior to the war, practically all mobile gun carriages in this country and abroad were transported on steel tired wooden wheels, and no springs were interposed between the axle and the gun mount. The same practice was followed as regards caissons for carrying ammunition, although shortly before the war, experiments had been made with a spring-supported caisson. During the war both the French and Germans brought out new materiel in which the gun and its mount were sprung above the axle. In some cases, solid rubber tires were introduced along with incorporation of the springs.

In view of the continuous tendency in automobile and truck construction to a decrease in the unsprung load, the question may arise as to why there should be any hesitation in making gun carriages as elastic as possible, and it is at this point that we are confronted with certain special considerations. In the first place, it is improbable that it will ever be possible to move artillery, particularly of the heavier types, at speeds greater than 15 miles per hour; and in fact it will only be under the most exceptional circumstances that it will be possible to move at this speed. This is due to the congestion of roads, which is unavoidable in the concentration of large masses of troops or equipment. Again, while it is desirable that the carriage should be lightly sprung in traveling, it must be rigid in firing; therefore, if we support the carriage upon springs, or use a spring wheel in case a satisfactory type is developed, it is necessary to provide a check on any spring movement during firing. This is, of course, entirely possible mechanically, but nevertheless introduces one more objectionable complication.

The question also arises as to the actual necessity for using a rubber tired wheel and at the same time spring-supporting the carriage. For a great number of years artillery carriages have, as stated, traveled on steel tired wheels without springs, and some of these carriages have traveled a few thousand miles over practically all conditions of road, including cobblestone, and at speeds up to 8 miles per hour. It would appear then, since we are only proposing to increase the speed to 15 miles per hour, due to use of tractors, that the use of either a rubber tired wheel or of springs alone would be adequate to meet the increased vibration and shock.

Solid rubber tires are objectionable on the grounds; first, of initial expense; second, cost of upkeep, including consumption of valuable time and labor; and third, the increased weight of the wheels, which is quite serious, particularly in the case of the smaller calibers of materiel, where, on account of being handled by hand, the weight element is very important.

If we use a steel tired wheel, it is reasonable to assume that we must spring-support the mount and it is probable that a spring-supported mount would render unnecessary the use of rubber tires in those cases where the weight, cost of maintenance, etc., are very objectionable. However, in this case materiel would undoubtedly be very noisy while on the road.

One solution of the problem would be answered by the use of a spring wheel, and it is believed that such a wheel can be developed. It is to truck manufacturers that the Department must look for the final development of a satisfactory spring wheel, as appropriations are not adequate to permit construction and experiment except to an insignificant degree.

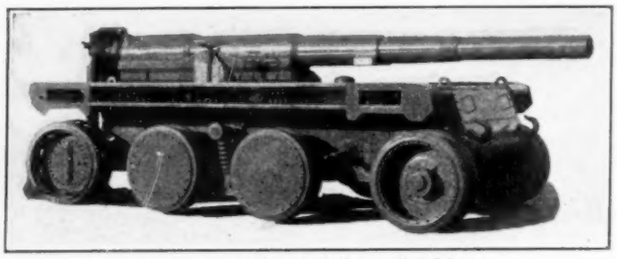
The length of this article does not permit mention of scores of points which are involved in the subject, but the few which have been touched upon are sufficient to show that the question is a broad one, which must be very thoroughly developed in order to provide the best possible type of artillery gun carriage.

Resistance of Artillery Trains. Tests have been conducted by the Artillery Division to determine the train resistance of railway mounts. Deductions from these tests show that it required on a straight level track, a draw-bar pull of approximately 30 pounds per net ton to start a train made up of railway mounts. At a speed of 5½ miles per hour the draw-bar pull was 22 pounds per net ton. On a one per cent grade the starting resistance of this train was ascertained to be 55 pounds per net ton. At a speed of 4 miles per hour this resistance came down to 37½ pounds per net ton.

The draw-bar pulls given above are the average for the different kinds of mounts. However, it was found that the mounts having inside journals such as the 16-inch howitzer, require considerable more draw-bar pull. This particular unit ran up as high as 38 5-10 pounds per net ton in starting, and came down to 25 pounds after being under way. These figures hold good for temperatures above 40 degrees Fahrenheit, but, of course, below this point the resistance will increase. The resistance on curves, while not decided, can be safely estimated to be from .5 to .8 pounds per net ton for each degree of curvature.

Roller Bearings. A series of tests have recently been made at Watertown Arsenal to determine the load capacity of roller bearings of large sizes. The rollers in the bearings tested were 4.9 inches long, by 1 1-4 inches in diameter—16 rollers in a cage. Inside diameter of the roller casing was 7 inches. Loads were applied to the bearings by means of the Emory machine at that Arsenal. A maximum load of 800,000 pounds was applied without injury to the bearings. At this load the coefficient of friction of the bearing was .0027. At an ordinary load of 300,000 pounds the coefficient of friction was .000783.

Caterpillar Mounts. The accompanying illustration shows one of the latest designs of the Ordnance Department in the development of the self-propelled mounts for heavy field guns. This wheeled caterpillar for the 155-mm. G. P. F. gun, Model 1918, is a combination type of self-propelled gun mount which can be run on four rubber-tired wheels or on an endless track with grouser action, which passes over the wheels. When traveling on the road or over good



155 mm. gun on Christie Self-propelled Mount

ground, this mount operates exactly as a motor truck, with the tracks (not shown in the illustration) carried on shelves along either side of the vehicle, and the center pair of wheels raised from contact with the ground. For maneuvering over varied terrain, steep grades, swamps, etc., the center pair of wheels are lowered to the ground and the tracks removed from the shelves and placed over the wheels. It requires only about thirty minutes for the gun crew to adjust the tracks over the wheels and the mount then becomes a caterpillar, with very low unit ground pressure, capable of negotiating terrain impassable for wheeled vehicles.

As a wheeled vehicle, the mount normally travels with the breech end of the gun first, although there are four speeds forward and four reverse, and the vehicle operates with equal facility in either direction. The speed of this mount, under favorable conditions, is in excess of twelve miles per hour, which was specified as the maximum needed for this type of gun, by the Field Artillery Board Report. When operating as a caterpillar with the tracks over the wheels, it is preferable, although not necessary, to maneuver the mount with the breech end of the gun first, as this places the tracks in tension on the ground side.

The mount is of the built-up structural steel type, consisting of two outside web plates tied together at the front end by cross members to form a box for housing the engine and transmission unit. Back of this engine compartment, is located the gun carriage bolted to horizontal plates supported by the side frames of the mount. At the rear, the web plates are tied together by a hollow axle supporting the two cast steel arms which carry the steering wheels.

Each side of the vehicle is equipped with four solid rubber tired double wheels, viz: the driving wheel, the steering wheel and the two center wheels mounted on a movable support. The two center wheels are lowered to take part of the weight of the vehicle when operating as a caterpillar, and raised to clear the ground when operating as a wheeled vehicle.

The driving power of the mount is a six-cylinder ball bearing gasoline engine located transversely in the front end of the mount. Power is transmitted through two disc clutches, one at either end of the engine crankshaft, to the transmission gear and gear sets and thence to the driving wheels through an internal gear drive. The final drive pinion shafts are each equipped with a hand brake.

Each link of the caterpillar track is equipped with a tooth of special shape which engages in sockets in the driving and steering wheels between the rubber tires of the wheels. These slots are open at the bottom to allow rocks and sand and other material to pass to the outside of the wheel, so as to not wedge the track tooth and thus throw the track off the wheels.

Rather extensive tests of a pilot vehicle of this type have indicated promising possibilities of this design, and a battery of four of these mounts will shortly be issued by the Ordnance Department for a prolonged service test in the field.

Decoppering of the 16-inch Gun. The possibility of the removal of copper from the lands and grooves of cannon, by the use of a tin-lead alloy introduced into the powder charge—which was developed and used to a limited extent by the Allied Armies during the World War—has been recently tried out in a 16-inch, 35-caliber gun, with most satisfactory results. The gun in question had been fired about 150 rounds and a heavy coating of copper of a granular form had accumulated, both on the lands and in the grooves; 20 rounds were fired as rapidly as possible, in which 450 grams of the alloy were introduced between the front end of the powder bag and the base of the projectile. The results shown by a visual inspection, are that practically all of this accumulation of copper has been removed and that remaining is in the form of a smooth plating. The alloy apparently caused no change in the muzzle velocity or range of this gun, and the final 10 rounds showed a marked improvement in deviation. The alloy used consisted of 60 per cent tin and 40 per cent lead, and was rolled into strips 1½ inches broad, 50 inches long, and weighing 20 grams each.

Research on Elasticity. An extensive program of experimental work has been carefully prepared by the Artillery Division for the purpose of determining the physical constants of the elasticity and resistance of the materials used in Ordnance construction.

Evidence has accumulated for quite a long time tending to cast most serious doubts upon the effective value of the hypotheses upon which the science of elasticity is established, particularly in their application to practice. Investigation of numerous cases of failure of material has shown the desirability of dealing with the material as it actually is and not as it is assumed to be for the purpose of mathematical treatment. Preliminary tests on tension and compression have already yielded enlightening and very encouraging results of far-reaching import. Briefly, they show that there is but one elasticity, that of the mass proper subjected to stress; that the Poisson ratio instead of being practically constant varies from zero to one-half; that the stresses and their resultant strains combine in simple additive manner.

The program which is now under way at the Watertown Arsenal comprises broadly: tensile and compressive tests of gun steels, and micro-photographic studies of the structure of the material before and after application of stress; tests with combined stresses applied hydraulically to the specimen, in such a way as to avoid the confusing effect of friction on the surfaces of application of the loads; tests of hollow cylinders of various proportions stressed by internal hydraulic pressure; some of these cylinders will be treated as simple ring elements, unsupported at the ends in conformity with the usual theoretical hypothesis, and internally along their full length; others will be internally pressed upon part of their length in order to determine the supporting influences of the ends, such as actually obtains in a cannon and which, so far, has not been dealt with by theory; these cylinder tests will be divided into two main parts, one dealing with a stressing which will extend nearly

to the natural elastic limit, and the other with stressing carried purposely beyond the elastic limit; this matter is essential for obtaining reliable data applicable to auto-frettage work.

Tests with compound cylinders will also be made so as to obtain reliable data on shrinkage processes.

In addition, the Watertown Arsenal has prepared the first gun tube to be treated by auto-frettage process; it is of the monoblock type, 155-mm. howitzer, and will be ready for treatment within a fortnight.

Other tests have practically been completed on the determination of the laws of "Buckling" through the flexure of beams. A paper is in preparation covering the main results obtained and giving in tabular form the formulas to be used in practice by the draftsman and designer.

Fire Control Instruments. Frankford Arsenal has nearly completed for test a type of stabilized balloon observation instrument for use in range determination for long range seacoast artillery. The ranges attained by the latest types of railway and seacoast artillery are such that the targets would, in a great many cases, be below the horizon, as viewed from the usual observation tower now in use in the Coast Defenses. The captive balloon equipped with suitable instruments for making the necessary observations provided a means of obtaining the desired data for all practicable ranges of the target, if atmospheric conditions are such as to permit visual observation. When visual observation is not possible, other methods of locating the target will be required. One of these methods is by means of observations taken from an airplane, itself being located by observation from the battery position. An instrument to permit the necessary observations from airplanes to be made is also being developed by Frankford Arsenal for test.

Frankford Arsenal has completed and will shortly ship to Fort Monroe for test, a Wilson Range Correction Board. This board is designed to take the place of the Pratt Range Board. The curve on the Wilson Board is generated by means of a flexible spline, several points of which are fixed by means of the given data, leaving the spline free between these points to take up a natural curve showing the total correction as a function of range.

Frankford Arsenal is now working on a combination direct and indirect fire sight for Railway Artillery Mounts. The 3-inch telescopic sights are satisfactory for direct fire on fixed mounts, but are subject to error when used on Railway Mounts which may be out of level. The present panoramic sight is satisfactory for indirect fire, but not for long range direct fire under the conditions of low visibility existing on the seacoast, hence the necessity for a sight which will enable the mount to be used to maximum advantage in both cases.

Three experimental types of fire control instruments for anti-aircraft artillery have been designed and are being constructed at Frankford Arsenal. These are the result of research and experience regarding the successful operation of anti-aircraft materiel gained during the War. They will, when placed in quantity production, complete the composition of fire control apparatus for all of our anti-aircraft artillery batteries.

Two Barr and Stroud two-meter base range and height finders of the "coincidence" principle have arrived at Frankford Arsenal. The optical parts of these instruments are the same as the ordinary two-meter base self-contained range finder. An exterior mechanism, which comprises two pairs of variable ratio gear wheels or toothed cones, is provided between the prism operating pinion and the elevating gear, so that the prism is thereby moved in accordance with the changes in the angle of elevation in order to keep the coincidence unaltered when the height of the target remains unchanged. A differential bevel gear train adds the rotational movements and imparts the sum to the axis of the intermediate wheel, thus resolving the height component. These are of the latest design and will be used in anti-aircraft gunnery to determine the altitude of an airplane.

Maj. L. B. Moody, Chief of the Tank, Tractor and Trailer Division, is now on a well-earned thirty-day leave.

Maj. M. B. Morgan, Chief Engineer of the Cleveland Tractor Company, was a recent visitor at the office of the Tank, Tractor and Trailer Division.

Capt. F. M. Seig, of the Gray Hawley Company, Detroit, Michigan, called at the office of the Tank, Tractor and Trailer Division recently. Captain Seig during the World War was in charge of engineering development at the plant of the Maxwell Motors Company, Dayton, Ohio.

Capt. D. M. Lasley was a recent visitor to the office of the Tank, Tractor and Trailer Division. During the World War Captain Lasley was in charge of engineering work on the 5-ton Artillery Tractor at the Chalmers Plant of the Maxwell Motors Company, Detroit, Michigan; also of the Experimental Station of the Tank, Tractor and Trailer Division, Speedway City, Indianapolis, Indiana.

Capt. F. E. Booth, now connected with the Hyatt Roller Bearing Company, was a recent caller on his old friends in the Tank, Tractor and Trailer Division.

Maj. C. A. Stolberg, former Mayor of Canton, Ohio, favored the Tank, Tractor and Trailer Division with a call recently. Major Stolberg is now devoting his energies to the consummation of several large real estate transactions.

Lt. Col. W. G. Wall attended the meeting of the Army Ordnance Association at Aberdeen Proving Ground, and also the meeting of the Ordnance Advisory Committee held just prior to the Aberdeen Meeting.

Capt. C. W. Keefer, now Research Engineer of the Crown Cork & Seal Company, Baltimore, Md., was a recent caller at the office of the Tank, Tractor and Trailer Division.

Mr. C. J. Cassese, formerly connected with the Procurement Division, Tank, Tractor and Trailer Division, called at the office of the Tank, Tractor and Trailer Division during the last month. Mr. Cassese is now Service Manager for the Four Wheel Drive Auto Company, Clintonville, Wisconsin.

Capt. RICHARD WRENSHALL, accompanied by Sgt. WILLIAM WRENSHALL, called recently to renew old acquaintances among the personnel of the Tank, Tractor ann Trailer Division. Captain Wrenshall is now Professor of Chemistry in the University of Honolulu, T. H.

Instructions have been given to the Peoria Engineering Office for the study and preparation of designs of a 7-ton corps type tractor.

It has been decided to construct one three-ton trailer caisson with self-container trailer wheels to accompany the self-propelled gun mounts, and the orders for the construction of same are now placed.

The redesign of 1½-ton trailer caisson has been completed and forwarded to Watertown Arsenal, also the revision of drawings of 10-ton trailer, the drawings were changed to show the modified design of a drawbar.

The stroboscope, which was purchased in France, and which is a devise to improve the observation from tanks and at the same time affording protection against bullets, has been received and is now in the Ordnance Office.

Practically all of the drawings required to actually assemble the medium tank are now at Rock Island Arsenal, and work of manufacture is under way at that point. Details of fittings and other parts of lesser importance are being completed as rapidly as possible.

Permission has been obtained from the Congressional Library for a permanent exhibit of photographs showing the various Ordnance motor vehicles. About 100 of the most interesting photographs are collected and will shortly be forwarded to the Library.

The test between the 10-ton tractor engine and the Holt M-14 engine, which was ordered at Rock Island Arsenal, has been completed, and while it was found that there were minor advantages in this engine, they were not considered of sufficient importance to warrant a change of engines being made in the present 10-ton tractors.

The White chassis, which was equipped in England with an experimental cable suspension and fabric track, has been received and is now at Aberdeen Proving Ground. where it was shown before the Army Ordnance Association meeting. The new Christie tank, which is a combined wheeled and track laying vehicle, was also exhibited at this meeting.

Copy of a test of a centrifugal oil cleaner for the Liberty engine has been received covering tests which were made by the Air Service at McCook Field. This centrifugal oil cleaner will be tested out at Rock Island Arsenal to determine its value for use in connection with the Mark VIII tank engines.

The compound Diesel engine, now being developed by Mr. Sperry, of the Sperry Gyroscope Company, has been studied by representatives of this Division, with a view of determining its adaptability for automotive work. It has been stated that this engine can be built so as not to weigh more than 10 pounds per horsepower.

Orders have been issued to cover the study and test of the Oakley valve. This valve is made from a nickel-copper alloy having approximately 67 per cent nickel, which is about the same as monel metal. It is claimed that this valve does not require regrinding, resists high temperatures, and will not warp. Tests of this valve in a mark VIII tank engine will be made at Rock Island Arsenal.

Spark plug fouling in the Liberty engine used in the Mark VIII tank has been minimized through the use of leakproof piston rings and modifying the piston by drilling in holes from the outer to the inner surface below the lower ring. Modified pistons have been provided by Rock Island Arsenal and necessary information given to Field Service so that all Mark VIII tanks engines can be re-equipped with these modified pistons.

The Ordnance Advisory Committee of the Society of Automotive Engineers met in Washington on Thursday, October 21, 1920, and at Aberdeen Proving Ground on Friday, October 22, 1920, to discuss the various subjects in connection with the development of automotive materiel by the Ordnance Department. The Society of Automotive Engineers was represented by Lt. Col. W. G. Wall, of the International Motor Corporation, Indianapolis; Mr. C. M. Manley, consulting engineer, New York; Captain Dent Parrett, of Parrett Tractor Company, Chicago; Mr. C. F. Clarkson, general manager, Society of Automotive Engineers, New York City; The Ordnance Department representatives were Col. C. L'H. Ruggles, Col. J. W. Joyes, Maj. W. A. Capron, Maj. B. O. Lewis, Capt. J. B. Haney, and Capt. G. R. Pennington, resident engineer of Tank, Tractor and Trailer Division, Cleveland, Ohio.

A preliminary exhibit and test of the tractor hand cart and the tractor power cart and reconnaissance tractor, designed and completed by the Syracuse Engineering Office, was held at Aberdeen Proving Ground and a few days later at Washington, D. C. These tests were highly successful from a technical standpoint, the reconnaissance tractor successfully performing over rough ground and demonstrated its ability to operate while floating on water. The power cart also was put through some difficult tests and afterwards run under its own power into a river where it proved its stability in water and capacility of floating. A similar test is also being made of the power cart designed at the Peoria Engineering Office. It should be particularly noted that these tests are being made on the first sample models to discover the defects in design and construction to serve as a basis for the construction of experimental models which will receive the regular service tests.

ANTICIPATING THE EARLY DEMOLITION of the temporary buildings "A" and "B" of the group located at 6th and B Streets, N. W., in this city, the Ordnance Department has removed all of its activities from these buildings. All of the Ordnance Office in Washington is now located either in the Munitions Building, or in Temporary Building No. 5, directly opposite.

THE REDUCTION IN THE CIVILIAN PERSONNEL of the Ordnance Department has steadily progressed since the signing of the Armistice. The maximum number of civilian employes in the Department, at any time, was 80,014, exclusive of those employed under agency contracts. This force has been reduced to 17,871, as of November 11, 1920. The distribution of this personnel for efficient operation has been a most difficult problem because of the fact that the number of establishments in operation and the property value under the control of the Ordnance Department can not be reduced in the same proportion as the personnel.

THE SMALL ARMS DIVISION
RIFLES ★ MACHINE GVNS ★ AVTOMATIC RIFLES ★ PISTOLS ★ REVOLVERS
HELMETS ★ TRIPODS ★ SMALL ARMS AMMVNITION AND TARGETS
★ ★ ★ TOOLS ★ ACCESSORIES AND CONTAINERS ★ ★ ★

The redesign of the 1918 tripod has been initiated with a view of overcoming the defects found as a result of service use.

Ordnance Pamphlet No. 1992, prescribing and describing Small Arms Targets and Equipment of Target Ranges has been revised and brought up-to-date. Basic and annual allowances of targets and target material for small arms target ranges have been prepared.

The manufacture of bipods for the Browning machine rifles has been completed. These bipods will be given a test along with the test of the Browning machine rifles. The manufacture of a small lot of Browning machine rifles has been completed and they will be given a service test within a short time.

Orders have been received from the Adjutant General's Office adopting for .30-caliber, model of 1906, ball cartridges, the clip known as the Ashworth Clip. This applies to future manufacture only, as the stock of clips now on hand is sufficient for several years at the present rate of cartridge expenditure.

Frankford Arsenal has been furnished a quantity of a tin decopperizing alloy, which has been used successfully in the prevention of metallic fouling in large caliber guns. This alloy will be used by Frankford Arsenal in connection with the development of a means for reducing or entirely obviating metallic fouling in small arms barrels.

A further order for ten special rifle stocks for the model of 1903 rifle modified for telescopic sight, has been placed at Springfield Armory. Four of these stocks are to be made without the pistol grip. These will be shipped to Camp Benning in connection with further tests of rifles equipped with telescopic sights.

The manufacture of Browning tank machine guns by converting a number of Browning machine guns into tank guns is proceeding satisfactorily. Beneficial information is being gained from their manufacture, inasmuch as the checking of the drawings is accomplished, thus insuring that they agree with the material as manufactured.

The development of the .50-caliber machine gun and its accessories is proceeding very satisfactorily and the indications, from a preliminary test recently made, are that it will perform equally as well as the .30-caliber gun of this type. A special study is being made of the type of rifling and chambering most practical for this gun. The design and developments of a belt-loading machine, a suitable ammunition belt, and a heavy tripod for this gun have been initiated.

This office is having prepared at Springfield Armory and the Colt's Patent Fire Arms Manufacturing Company an exhibit of small arms and machine guns used by the United States during the World War. These weapons are to be a part of the French Government's official collection of weapons used in the World War, and are to be exhibited at the Hotel des Invalides, Paris, France. A request for duplication of this collection for the Royal Belgian Museum at Brussels has since been received.

Twelve special rifle stocks with pistol grips for the model of 1903 rifle have been manufactured at Springfield Armory to the dimensions suggested by the Experimental Department of the Infantry School of Arms, Camp Benning, Georgia. These stocks are of two types, one being manufactured from the model of 1903 gun stock blank and the other being manufactured from the model of 1917 blank, which is somewhat larger. Five of each type of stock assembled with the rifle have been shipped to the Infantry School of Arms, Camp Benning, Georgia, for test.

The Armory has been demobilized from its war-time activities until now it is practically at its peace-time strength.

The number of officers has been decreased from 154 (including officers sent here for training), and the employees from 5,348, at the signing of the Armistice, to 7 officers and 1,070 employees at the present time.

The output of U. S. magazine rifles, caliber .30, model of 1903, has been decreased from 1,500 to 125 daily, during the same period, plus the usual peace-time production of spare parts, bayonets, sights, etc.

The improved design of butt stock for the Browning automatic rifle was made by the Machine Gun Section of the Small Arms Division, and submitted to Camp Benning for test. It has been tested and a favorable report made thereon. The improvements made were the lengthening of the butt stock ¾ of an inch to give the rifleman more freedom in firing the rifle, rotating the butt stock to the right five degrees with the buffer tube as an axis and reinforcing of the forward end of the stock to prevent season cracking. The Adjutant General has approved the recommendations of Camp Benning to substitute this design of stock in future manufacture of Browning automatic rifle stocks instead of the standard stock as now used.

Work has been initiated at Frankford Arsenal and Springfield Armory on the development of a suitable solution for use by enlisted men in the cleaning of rifles after firing service ammunition. The present ammonia solution is entirely satisfactory for the purpose of cleaning rifles and removing metallic fouling therefrom, but it has been found in practice that in the hands of the ordinary enlisted man, this solution is not entirely suitable in that unless very close supervision is exercised, the rifle upon which the solution is being used is liable to be damaged by the solution. By the present development, it is hoped to obtain a solution which is entirely harmless and which at the same time will be satisfactory for use during target practice season, it being intended that ammonia solution will only be used for the final cleaning of rifles, and then only under

the supervision of a commissioned officer or an experienced non-commissioned officer.

Lieut. Col. Wm. A. Borden, Ord. Dept., U. S. A., visited Springfield Armory on September 17 and 18, 1920, for the purpose of conferring with Capt. A. H. Skinner relative to progress on development of 37-mm. guns.

Capt. W. T. Gorton, Ord. Dept., U. S. A., visited Springfield Armory on October 25, 1920. Proceeded to Colt's Patent Firearms Mfg. Co., Hartford, Conn., to witness test of caliber .50 gun.

Capt. S. G. Green, Ord. Dept., U. S. A., visited Springfield Armory on October 25, 1920. Proceeded to Colt's Patent Firearms Mfg. Co., Hartford, Conn., to witness test of caliber .50 gun.

Lieut. Col. W. L. Clay, Ord. Dept., U. S. A., visited Springfield Armory on November 2, 1920, to discuss new designs in the development of the 37-mm. airplane cannon. cannon.

Lieut. H. A. Sutton, Ord. Dept., U. S. A., visited Springfield Armory on November 2, 1920, to discuss new designs in the development of the 37-mm. airplane cannon.

Lieut. T. C. Gerber, Ord. Dept., U. S. A., visited Springfield Armory on November 4, 1920, to familiarize himself with the manufacture of rifles.

Col. W. A. Phillips, Ord. Dept., U. S. A., Commanding Officer Frankford Arsenal, visited Springfield Armory on November 5 and 6, 1920, and conferred on questions affecting Arsenal administration.

The Springfield Armory Football Team played their initial game in the First Corps Area Football League on November 6th, when they met the Fort Ethan Allen team at Burlington, Vermont, and won by a score of 14 to 13 points.

The Ordnance team is composed entirely of officers and enlisted men stationed at this Armory, and is the first team of its kind to represent this station on the gridiron. They have been working out regularly under the direction of the athletic officer and indications point to a successful season.

SPRINGFIELD ARMORY NOTES

A number of rifles equipped with the Relaxing Trigger, invented by Major Murray Baldwin, U. S. A., retired, are now being manufactured at the Springfield Armory for test. This work will shortly be finished, when the rifles will be sent to the School of Musketry at Camp Benning, Georgia, for experimentation and report.

A rifle with a Relaxing Trigger was made by the inventor, Major Baldwin, some 15 years ago, but he was not satisfied with it as it was not safe and had other serious defects. He has recently improved the device and it is in this form that it is being manufactured at the Springfield Armory.

About ten thousand shots were fired with rifles so equipped at the Marine Corps rifle range at Wakefield in a semi-official test. It has received favorable comment from several general officers who have investigated the device and some of whom have seen it in use on the target range.

General Hunter Liggett recommended that it had sufficient merit to warrant a test being made at government expense. The Technical Committee of the Ordnance Department accordingly directed the manufacture of an experimental lot of ten.

The controlling principle is explained in the title "The Relaxing Trigger." All triggers in use at present have to be compressed in order to discharge the firearm, but with this proposed device the trigger is pulled back first; aim is taken; and to fire, the finger is allowed to relax to the tension of the compressed trigger.

It is claimed by the inventor that five very desirable results can be attained by this mechanism, to-wit:

1. Recruits can be instructed to shoot with an accuracy of over forty out of fifty in about one-fourth the time now necessary, as the human error due to flinching is entirely prevented.
2. Greater accuracy can be attained than is the case with the present or compression type of trigger.
3. Greater rapidity of fire is attained.
4. Battle fire will be kept low, as fully ninety per cent of the shots that go high from flinching or improper trigger squeezing will be kept from going over the objective; and the objective will either be struck or the shots will strike low.
5. The safety of the device is greater than is afforded by the compression trigger.
6. That the device is simple in mechanical construction and durable and as far fool-proof as is attainable with any mechanism.
7. The present safety latch is eliminated. The safety latch of the Relaxing Trigger being near the trigger bow and controlled by the middle finger. This results in the manufacture of the bolt sleeve being simplified and the sleeve "D" is a symmetrical piece with nothing projecting therefrom, as is now the case with the present sleeve.

Major Baldwin's idea is that the average man cannot take full advantage of the mechanical accuracy of the rifle, due to the human error and that flinching is the greatest trouble to contend with in the instruction of new troops. It is believed that the Relaxing Trigger will be for the greatest good of the greatest number in the minimum of time.

The illustration gives a good idea of the device. The reason alleged for its superiority is that it is much easier to do one thing at a time than to do two things and that with the present type of trigger one has to aim and at the same time compress the trigger. And that the best results are attained when the marksman is giving his whole attention to the act of aiming, which is very difficult to do with the compression trigger, but is easy and natural to do with the Relaxing Trigger.

The method of firing is as follows: The safety latch "A" is automatic when in use, but when on the march is securely fastened in an immovable position by the locking plate marked "B." Place the forefinger on the locking plate which frees the automatic safety and with a continuance of the same motion place the trigger finger on the trigger. Then jerk the trigger backward, the faster the better, and the rifle will not be discharged. Now permit the trigger finger to yield to the tension of the compressed trigger. During this time think only of the objective. This is easy to do for the trigger will pull the finger forward. All that has to be done is to let the trigger pull the finger. The trigger action is thus kept on the sub-conscious plane and the entire attention can be given to aiming.

Should it be desired to execute "cease firing" after the trigger has been compressed the rifle will be made "safe" by simply extending the middle finger and thus removing it from the automatic safety latch which must be held up during *the entire time* the trigger is moving forward or the rifle will not be discharged.

When this safety latch is pressed up no manipulation of the trigger will discharge the piece. After firing and for carrying the rifle on the march the locking plate is applied, which makes the automatic safety latch immovable, but it

may be applied while bringing the rifle to the shoulder.

It will be seen in the illustration that there is an enlargement of the stock of something of the appearance of a pistol grip. This is called a finger grip "C," and it is claimed that it has advantages, as a pistol grip merely facilitates pulling the stock directly against the shoulder, while with the finger grip the same thing results.

An additional advantage is that the convulsive gripping of the stock so characteristic of recruits is prevented, as the other fingers have almost no power to grip the stock when the middle finger is pulling straight back on the finger grip and the trigger finger is pulling similarly on the trigger.

It is to be noted that the forefinger (or trigger finger) with this device assists in holding the stock against the shoulder in taking aim, which, of course, is not the case with the present or compression trigger.

The device is a very radical departure from present practice, and the inventor contends is correct from every

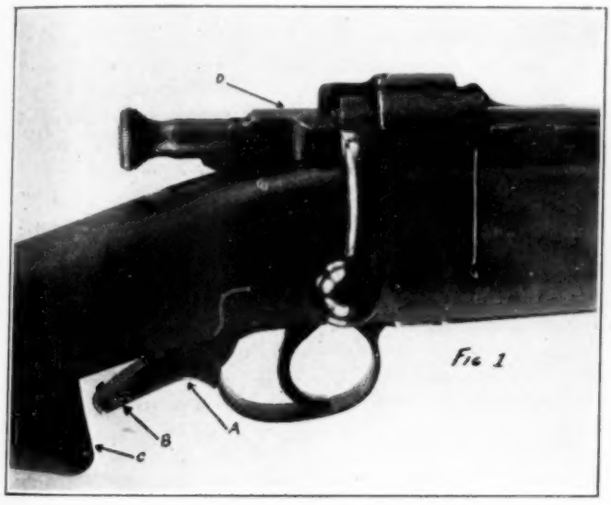


Fig. 1

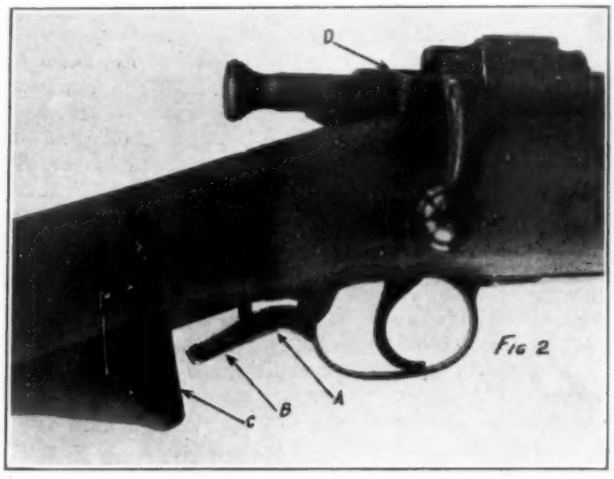


Fig. 2

psychological and physical viewpoint. Major Baldwin will accompany his guns to Camp Benning where actual tests may show the advantages or disadvantages of his ideas as applied to Small Arms.

Major Baldwin explains Fig. 1 as follows:

"This shows the Relaxing Trigger with the rifle loaded and locked, that is with the automatic safety rendered immovable.

"A" is the automatic safety. No manipulation of the trigger at any time will discharge the rifle unless the automatic safety is pressed up against the stock.

"B" is the locking plate by which the automatic safety is held immovable when the rifle is carried while on the march, and takes the place of the present safety latch.

"C" is the finger grip. This affords a straight pull against the shoulder as a pistol grip does. It is made for the middle finger only and it is impossible to grasp the stock with the third and fourth fingers if the second finger is pulling against the finger grip. Canting the rifle with these fingers is thus prevented.

"D" is the way the sleeve will appear. It is to be noted that the present safety latch is eliminated and that the new sleeve has no protuberences which will interfere with the handling of the bolt."

Fig. 2 shows the Relaxing Trigger with the locking plate pressed in, which permits the automatic safety to function.

Major Baldwin explains this illustration as follows:

"Suppose the rifle to be loaded and locked as in Fig. 1, the trigger finger is pressed against the locking plate from the rear (it cannot be moved otherwise.) This moves the locking plate to the left so that the recess shown in the illustration is brought under the locking pin which is to be seen protruding from the stock toward the locking plate which is in contact with it. When the locking plate is moved to the left the recess, as shown in the illustration, is brought under the locking pin which is then free to play in this recess and through a hole in the safety latch of the same size.

"The trigger finger is now brought forward and engages the trigger. The rifle is now brought to the shoulder, at the same time pulling the trigger back, the quicker the better. The middle finger will now lie against the finger grip "C," and the rifle is held against the shoulder by the action of the forefinger and the middle finger.

"No thought need be given to pressing the automatic safety upward as the pressure of the middle finger against the finger grip will cause the automatic safety to move up without any volitionary effort.

Aim is now taken and then the trigger is allowed to move forward which discharges the rifle. This movement is nearly three-quarters of an inch, so there is nothing resembling a hair trigger.

"Should it be desired to execute 'Cease firing' all that has to be done in case the trigger is compressed, is to move the middle finger forward, thus freeing the automatic safety, and the rifle is 'safe.'

"When the automatic safety is rendered movable by unlocking it there is no effect on the trigger, which can be pulled back and forth with impunity. The rifle cannot be discharged unless the automatic safety is held up. This is pressed into the stock during the entire time of the trigger's forward motion, should the trigger be moved so far forward as to be at the point of discharging the rifle. Nevertheless, if the middle finger is moved forward thus freeing the automatic safety, the trigger may move forward but the rifle will not be discharged.

"It will be seen that the trigger finger assists in holding the rifle against the shoulder up to the moment of relaxing the trigger. Flinching will not discharge the rifle, as the backward movement of the trigger cannot result in discharge.

"While on the march the locking plate is pushed from the left side from rear to front, this causing the locking plate to come under the locking pin and all movement of

the automatic safety being prevented, the rifle cannot be discharged, as pulling the trigger has no effect unless the automatic safety is free to move upward."

Development of Metallurgical Department at Springfield Armory

1. Springfield Armory found it necessary at the beginning of the war to centralize the work of testing and heat-treating steel in a Metallurgical Department. This department was organized in June, 1917, and given charge of all testing and heat-treating operations and of all metallurgical investigations connected with rifle manufacture.

2. It was necessary to provide a new building for the laboratory work of this Department, which building is located at the Hill Shops and adjacent to the Case Hardening Room. It provides space for chemical, physical, metallographic and heat-treating laboratories. The building was completed and occupied in May, 1918, the testing work having been developed before this time in rooms in the old Annex Building. The new location of the Laboratory proved very satisfactory, facilitating supervision of the component hardening when the rate of production was rapidly increasing, and close control of the quality of production was vitally important. The policy of laboratory supervision of the hardening proved effective in making acceptable, by modified heat treatments, material that otherwise would have been rejected for faults originating in the manufacture of the steel or developing in forging or machining. This resulted in the saving of material and also of rifles produced when they were urgently required.

3. A system has been developed which provides for chemical, physical and work tests of material used in components or tools in the manufacture of the rifle. Routine tests are also made, covering the acceptance, on compliance with specifications of oil, wood and miscellaneous materials. Investigations are made of complaints of poor tools or bad stock and of causes why production does not conform to standards set by carefully supervised acceptances and work-tests of raw material. These investigations lead to efficiency by directly eliminating shop excuses for poor results, and are indirectly used to establish standards of efficiency. This practice is a natural result of having undivided responsibility for the acceptance of the raw stock and the quality of the heat-treated finished product. Failures in machining, or of tools, are reported to the head of the Metallurgical Department, who has available records of acceptance tests and histories of heat-treatment, so is in a position to readily discover causes of abnormal results.

4. The heat-treating methods of carburizing, hardening, tempering and annealing have been modified and improved, based on the result of experiments in the metallographic and heat-treating laboratories. As a result of these experiments, practically all the furnaces in the hardening and annealing rooms have been replaced by new ones adapted to more efficient and economical methods. These changes have been made without interfering with production, and the modified methods now in operation have proved to be more economical of material, labor and floor space, and to produce more uniform products than the older methods. This is particularly true of the method of carbonizing with gas instead of with charred bone. The labor of packing parts in carburizing material is eliminated. The time and cost of the operation are considerably reduced, and over two-thirds of the floor space occupied by the old case-hardening furnaces has been released.

5. Other improvements that have helped to relieve the congestion in handling the many differently treated components in the hardening room, are the use of an air-hoist and trolley track system and the segregation of the washing and tempering work in a separate room. In connection with the heat-treatment of case-hardened parts, it has been found that the second hardening operation, to toughen the core and refine the case, can be most effectively carried out from a bath of molten salts. The molten bath method gives better temperature control, better rate of production per furnace and unit of labor, cleaner parts and less distortion than the method of open fire-hardening.

6. The annealing, as carried out at the Water Shops, has been radically changed and the capacity for this work considerably increased. Two units of two-chamber heating furnaces have replaced eleven small non-continuous furnaces. By maintaining a well-insulated heating chamber continuously at a high annealing temperature, a great fuel economy results, over the old method, wherein the furnace and the work were cooled down every eight hours. In the old method the fuel cost was largely that of re-heating the furnace. The floor space acquired by adopting this method has been used to provide equipment for barrel heat-treatment, it having been found desirable to have facilities in the plant for this work.

7. The research work of the Metallurgical Department has included experiments to establish the best steel and heat-treatment for components of the rifle and for many of the tools and gauges used in its manufacture. Many proposals to change the classes of steel have been investigated, but it has generally been found that no radical changes in the kind of steel used are necessary to give the rifle parts as designed entirely satisfactory properties for field use, provided that the heat-treatment is properly controlled and inspected. Drastic over-tests and firing tests to destruction carried on in conjunction with heat-treating experiments have resulted in the development of parts capable of remarkable resistance to abusive treatment. This is particularly true of the improved heat-treated barrel, receiver, bolt and bayonet.

8. The fact that it was possible to get immediate improvements in production from tests developed in the Laboratory, and to decrease the number of failures in production while the rate of production was increasing, is a result of the Laboratory having developed during the emergency war period and also of the fact that the Laboratory and heat-treating departments were under the same head. It is desirable to emphasize this point, because so many establishments do not get sufficient co-operation between the research or test departments and the manufacturing departments. While there are certain advantages in having the Laboratory and research work isolated from production, results here have shown that intimate relation between the two branches makes the work of the Laboratory of much more direct value to production. While most of the research work here has been purely incidental to production, there has developed a practical point of view and an appreciation of the problems of manufacture that can not be obtained from indirect contact. While many valuable suggestions are received from those having no direct experience in rifle manufacture, such suggestions generally have to be greatly modified before being adapted to our established practice. It is our experience that more fertile suggestions and subjects for investigation can be developed in the plant where the manufacture is actually taking place. Many possible lines of research have been brought to the attention of the Laboratory during the rush of war production, which it was not possible to investigate in detail, but which would abundantly repay thorough investigation. It is believed that the standard of efficiency in small arms manufacture can be considerably raised by further development of the metallurgical problems that

AIRCRAFT ARMAMENT DIVISION

THE AIRCRAFT ARMAMENT DIVISION is charged with the design, development, procurement, manufacture and inspection of all items of aircraft armament including in general, bombs, bomb sights, bomb racks, aircraft machine guns, aircraft cannon and accessories pertaining thereto.

The organization handling this work is divided into a Washington Office and a Dayton Branch Office.

The Washington Office is charged with the administrative work of the Division and, in addition, handles all design and development work pertaining to bombs.

The Dayton Branch is charged with the design and development of aircraft machine guns, aircraft cannon, bomb racks and accessories pertaining thereto.

In addition to these offices, certain of the Ordnance and commercial establishments are undertaking work on aircraft armament as follows:

Springfield Armory is charged with the design and development of the improved Baldwin 37-mm. aircraft gun.

An organization at Frankford Arsenal is charged exclusively with the design and development of bomb sights; is handling the development of equipment for the testing of bomb sights, and the equipment required in bomb ballistic tests. Frankford Arsenal is also developing three special types of fuses for bombs.

Aberdeen Proving Ground is carrying on all tests pertaining to bombs, bomb sights and bomb ballistics with the exception that practically all theoretical work, wind tunnel and certain specific ballistic tests are being undertaken at the Bureau of Standards.

Watervliet Arsenal is producing the new 100, 250 and 550-pound demolition bombs and the new 25-pound fragmentation bombs which are to be used in tests at Aberdeen. Frankford Arsenal has produced the fuses for these bombs.

Frankford is manufacturing a quantity of 8-ounce Incendiary Bombs with a number of experimental containers which will be used in development tests at Aberdeen.

Rock Island is producing a number of bomb racks of various types for service tests and for installation on new types of airplanes.

Springfield Armory is modifying all Browning Aircraft guns to improve their functioning and to enable them to be operated by the Nelson synchronizing gear.

Watertown Arsenal has recently constructed a series of fin assemblies for attachment to the 1046-pound, 12-inch mortar D. P. projectile. It is planned to test this projectile as an armor-piercing bomb. The fuses to be used in the test have been manufactured at Frankford Arsenal.

Frankford Arsenal has manufactured a test lot of nose and tail fuses for demolition bombs, and nose fuses for fragmentation bombs to be used in acceptance tests of the designs of the fuses. Picatinny Arsenal is developing the delay elements for these fuses. That Arsenal is also loading practically all bombs to be used in experimental tests.

Colts Patent Fire Arms Mfg. Co., of Hartford, Conn., is developing the .50-caliber Aircraft Machine Gun. Sargent & Company, of New Haven, Conn., are developing the metallic links and link-loading machines to be used with the .50-caliber aircraft machine gun. Frankford Arsenal is developing the .50-caliber ammunition for this gun.

Some of the personnel working on the development of aircraft armament are as follows:

Washington Office, Aircraft Armament Division—
Maj. Wm. A. Borden,
Capt. C. H. M. Roberts,
1st Lt. L. J. Meyns.

Dayton Branch, Aircraft Armament Division—
Maj. W. L. Clay,
Capt. W. T. Gorton,
1st Lt. H. L. Campbell.

Frankford Arsenal—
Col. W. A. Phillips, in command of arsenal and on small arms ammunition.
Maj. H. K. Rutherford, in charge of fire control design development.
Maj. J. H. Woodberry, on bomb fuses.
Capt. E. J. Loring, on bomb sights.
Captain Frank Short, on testing bomb sights and ballistics of bombs.

Springfield Armory—
Col. T. L. Ames, in command of arsenal.
Maj. E. McFarland, in charge of shops.
Maj. J. S. Hatcher, in charge of experimental department.
Capt. A. H. Skinner, on 37-mm. gun.

Aberdeen Proving Ground—
Lt. Col. H. W. Schull, in command.
Major James Kirk, in charge of proof department.
Lt. S. R. Stribling, in charge of bomb and bomb sight testing and ballistic work on bombs.
258th Aero Squadron, 18th Balloon Company, Air Service organizations stationed at Aberdeen for test work on aircraft armament.

Bureau of Standards—
Dr. S. W. Stratton, director.
Maj. F. C. Brown, assistant to director.
Dr. L. J. Briggs,
Dr. H. L. Dryden, ballistic work on bombs.

Colts Patent Fire Arms Manufacturing Company—
John Browning,
F. F. Moore,
50-caliber aircraft machine gun.

Sargent & Company—
J. H. Shaw, .50-caliber metallic links.

Recent Investigations at the Bureau of Standards

Continued from Page 108.

the same results as were accomplished hundreds of years ago. Swords made at Damascus are still supposed to have been the best of their kind ever made. As a matter of fact, the excellent quality of these products was very often due to the extremely high grade raw materials used and not to any secret or very meritorious production process.

A short time ago the Metropolitan Museum of Art of New York City submitted to the Bureau quite a large number of samples cut from ancient armor with the request that the same be analyzed and examined to determine, if possible, the character of the processes employed in its production. All of the samples submitted were many hundreds of years old, and, unfortunately, were so corroded that it was extremely difficult to obtain sufficient material for some of the tests. For instance, the carbon determination had to be made over the entire cross-section of each sample, as the material was so thin that an analysis could not be made of the different layers. In examining the specimens microscopically, they were so cut and polished as to expose the different sheets out of which the finished piece was formed. The chemical and microscopic examination indicated that the metal had been produced by the old cementation process, after which the iron had been carbonized and hammered into thin sheets. These differed considerably in hardness, probably due to varying carbon content, though, as before stated, it was impossible to determine the amount of carbon chemically in each layer. These sheets were then welded together and the whole hammered into the desired shape and quenched to produce the final hardening effect. Traces of copper were found in all the samples, but it is believed that this was in all probability present in the original iron ore and was not introduced in the manufacturing process. The very high grade raw materials used was indicated by the fact that no impurities of any sort were found which could not be accounted for in the original ore or charcoal with which it was reduced.

Conference to Formulate a National Plastering Code

The use of plaster is becoming of increasing importance and enters into practically every building operation. That there is need for national uniformity in the rules governing such construction is indicated by the requests which the Bureau is continually receiving from those interested in the production and uses of plaster.

In compliance with these requests, the Bureau has undertaken to formulate a national plastering code with the object of embodying in it specifications for all materials used in wall plaster, as well as complete directions for their use. The results of this work will eventually form the basis of a Bureau publication, and it is hoped that this will be in such shape that it can be adopted verbatim by municipal and State legislative bodies in the preparation of building codes. The specifications will be divided for convenience into the following chapters: 1. Introduction; 2. Preparation for masonry surfaces, and specifications for lath; 3. Specifications for plastering materials; 4. Directions for the mixing and application of plaster; 5. Properties of finished plaster; 6. Renovation and decoration; 7. Miscellaneous: suspended ceilings, corner beads, etc.

A conference has been called to assist in this work, consisting of the representatives, first, of the manufacturers and plasterers; second, of the users of the same; third, of independent organizations—such as the National Board of Fire Underwriters, the Supervising Architect of the U. S. Treasury Department, etc., and, fourth, of the Bureau of Standards. The chief of the Lime Section of the Bureau has been chosen chairman of the conference.

The first meeting was held on September 14, at which eleven members were present and six more offered carefully prepared written communications. Work has been conducted by mail since January so that it was possible to at once enter into a discussion and criticism of chapters 1 and 2 of the specifications. As a result of the session, all of chapter 1 and about three-fourths of chapter 2 were adopted.

Another meeting of the conference will probably be held in December when additional material will be ready for discussion.

Spectroscopic Analysis of Gold

An interesting spectroscopic analysis has recently been conducted at the Bureau. Nine standard samples of mint gold, alloyed with silver, copper and iron, were submitted to determine whether the amount of these impurities could be shown quantitatively through the analysis of spark spectra. As a result of this work, it appears that the common impurities of gold can be estimated by this method with an error of not greater than a few hundredths of 1 per cent in the range from 0.0001 to 1.0 or more per cent.

Springfield Armory Notes

Continued from Page 154

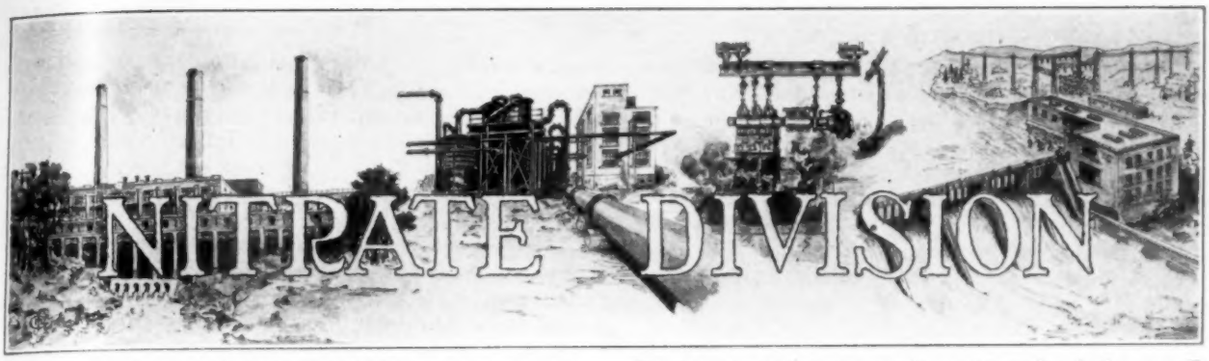
recent experience has shown are so vitally connected with the quality and efficiency of the small arms manufacture, and whose solutions were difficult under the stress of emergency production.

Experimental and Designing Work

Semi-Automatic Shoulder Rifle, Model of 1920, Experimental. The most important designing work being conducted at Springfield at this time is the construction of one semi-automatic shoulder rifle, Model of 1920, Experimental. The design of this rifle was originated by John C. Garand. In size and weight the rifle is practically the same as the Springfield, but has the important difference that it embodies the self-loading principle. When each shot is fired some of the surplus energy is used to throw out the empty shell and place a new shell in the chamber with the rifle cocked and ready for firing again.

Receiver Sights for the Model 1903 U. S Rifle. As a result of the late war, a receiver sight for the U. S. Springfield Rifle, Caliber .30, Model 1903, has been found to be highly desirable. Four different types of such sights are at present under design by Springfield Armory. The most promising of these has a wheel on the left-hand side of the rifle, graduated from zero to 1600 yards, and by one turn of this wheel the rear sight can be raised all the way from zero to its highest position.

Rust-Proof Steel for Rifle Barrels. For some time past an attempt has been made to discover a steel which would resist the erosion caused by acid residue left by powder fouling. With this end in view, an attempt was made to manufacture several rifle barrels out of the rust-resisting steels commercially known as "stainless steels." The results obtained to date have not been satisfactory as the machining qualities of the material are so poor that it is extremely difficult to work. A further experiment along the same line contemplates the use of Monel Metal for rifle barrels.



Future activities of the Nitrate Division are at present almost entirely dependent upon the action of Congress upon the Wadsworth-Kahn Bill which is being printed practically in full below, not only on account of its interest to all patriotic Americans who are today giving thought to our future military security, but on account of its vital importance to those engaged commercially in the production of artificial refrigeration, to our fast-expanding chemical industries, and to our agricultural interests in general:

Senate 3390—House of Representatives 10329.

A BILL To provide further for the national defense; to establish a self-sustaining Federal agency for the manufacture, production, and development of the products of atmospheric nitrogen for military, experimental, and other purposes; to provide research laboratories and experimental plants for the development of fixed-nitrogen production; and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War is hereby authorized and empowered to designate any five persons to act as an organization committee for the purpose of organizing a corporation under authority of and for the purposes enumerated in this act.

Organization.

The persons so designated shall, under their seals, make an organization certificate, which shall specifically state the name of the corporation to be organized, the place in which its principal office is to be located, the amount of capital stock and the number of shares into which the same is divided, and the fact that the certificate is made to enable the corporation formed to avail itself of the advantages of this act. The name of such corporation shall be United States Fixed Nitrogen Corporation.

The said organization certificate shall be acknowledged before a judge of some court of record or notary public, and shall be, together with acknowledgment thereof, authenticated by the seal of such notary or court, transmitted to the Secretary of War, who shall file, record, and carefully preserve the same in his office. Upon the filing of such certificate with the Secretary of War as aforesaid the said corporation shall become a body corporate and as such and in the name United States Fixed Nitrogen Corporation shall have power—

First. To adopt and use a corporate seal;

Second, Third, etc. (Here follow provisions covering the usual legal powers of an ordinary commercial corporation.)

The corporation shall be conducted under the supervision and control of a board of directors, consisting of not less than three nor more than eleven members, to be appointed by the Secretary of War. The directors so appointed shall hold office at the pleasure of the Secretary of War. The Secretary of War shall be ex officio chairman of the board, and shall have power to designate one of the directors as vice chairman. The vice chairman shall perform the duties of chairman in the absence of the Secretary of War.

The board of directors shall perform the duties usually appertaining to the office of directors of private corporations and such other duties as are prescribed by law.

Powers of the Corporation.

The corporation shall have power—

(a) To purchase, acquire, operate, and develop in the manner prescribed by this act and subject to the limitations and restrictions thereof the following properties owned by the United States:

1. United States nitrate fixation plants numbered 1 and 2, located, respectively, at Sheffield, Alabama, and Muscle Shoals, Alabama, together with *(a)* all real estate used in connection therewith; *(b)* all tools, machinery, equipment, accessories, and materials thereunto belonging; *(c)* all laboratories and plants used as auxiliaries thereto, including the fixed-nitrogen research laboratory at Washington, the Waco limestone quarry in Alabama, the electric power unit at the Warrior River Station of the Alabama Power Company, and transmission lines, and any others used as auxiliaries of United States fixed-nitrogen plants numbered 1 and 2.

2. Any other plants or parts of plant, equipment, accessories, or other properties belonging to the United States which are under the direct control of the President or of the War Department and which the President or the Secretary of War may deem it advisable to transfer, convey, or deliver to said corporation for use in connection with any of the purposes of this act or for any purpose incidental thereto.

(b) To acquire, establish, maintain, and operate such other laboratories and experimental plants as may be deemed necessary or advisable to assist it in furnishing to the United States Government and others at all times nitrogen products for military or other purposes in the most economical manner and of the highest standard of efficiency.

(c) To sell to the United States such nitrogen products as may be manufactured by said corporation for military or other purposes.

(d) To sell any or all of its products not required by the United States to producers or users of fertilizers, or to others.

(e) By direction of the President, to act as his agent in carrying out and performing any or all of the duties imposed upon him by section 124 of the act of June 3, 1916, known as the national defense act, including, after its completion, the operation of the hydro-electric power plant now being constructed at Muscle Shoals and the use and sale of the hydro-electric power to be developed under authority of the act of June 3, 1916, aforesaid; and the President is authorized, in his discretion, to delegate to the corporation any and all powers and duties conferred or imposed upon him by said act which relate to the production, development, or manufacture of atmospheric nitrogen products, or which are incidental thereto, and to pay into the treasury

of said company any unexpended balance out of the appropriation made by section 124 of the act of June 3, 1916, such funds to be used by the corporation for the purpose of said act as amended by this act.

(f) To enter into such agreements and reciprocal relations with others as may be deemed necessary or desirable to facilitate the production and sale of nitrogen products on the most scientific and economical basis.

(g) To purchase, lease, or otherwise acquire United States or foreign patents and processes, or the right to use such patents and processes.

(h) To obtain from the United States or from foreign Governments patents for discoveries or inventions of its officers and employees, and in the discretion of its board of directors to require any and all of its officers and employees as a condition of their employment to enter into agreements with the company that the patents for all such discoveries or inventions shall be and become in whole or in part the property of the corporation.

(i) To assume any or all obligations of the United States entered into in connection with the construction, maintenance, and operation of the plants to be transferred to the corporation under the provisions of this act.

(j) To deposit its funds in any Federal reserve bank or with any member bank of the Federal reserve system.

(k) To sell and export any of its surplus products not purchased by the United States or by persons, firms, or corporations within the United States.

(l) To invest any surplus of available funds not immediately used for the operation, construction, or maintenance of its plants or properties in United States bonds or other securities issued by the United States.

(m) To lease or purchase such buildings or properties as may be deemed necessary or advisable for the administration of the affairs of the corporation, or for carrying out the purposes of this act; and with the approval of the Secretary of War to lease to other persons, firms, or corporations any of its properties not used or needed by the corporation, or to enter into agreements with others for the operation of such properties. In the operation, maintenance, and development of the plants purchased or acquired under this act, the corporation shall be free from the limitations or restrictions imposed by the act of June 3, 1916, and shall be subject only to the limitations and restrictions of this act.

Capital Stock.

The capital stock of the corporation shall be divided into two classes, to be known as common and preferred. The common stock shall be without par value. The company shall have no power to issue stock, except that issued to the United States under authority of this act.

In exchange for the properties purchased or acquired from the United States, and from time to time transferred, conveyed, or delivered to the corporation by the President or by the Secretary of War, as provided by this act, the corporation shall cause to be executed and delivered to the Secretary of War a certificate for all of the common stock of the corporation, which certificate shall be evidence of the ownership by the United States of all such common stock. In consideration of the issuance of such common stock to the Secretary of War, the President and the Secretary of War are authorized and empowered to transfer, convey, and deliver to the corporation all of the real estate, buildings, tools, equipment, supplies, and other properties belonging to, used by, or appertaining to the plants and properties to be acquired by the corporation under the terms of this act, and to transfer, convey, and deliver as and when they may deem it advisable any other equipment, accessories, plants or parts of plants, or other property referred to in this act and which the corporation is authorized to acquire or purchase from the United States under its provisions.

The President or the Secretary of War as a condition of the transfer, conveyance, or delivery to the corporation of any property herein referred to, may require the corporation to assume any and all agreements and obligations entered into by the United States in connection with the construction, maintenance, or operation of such plants or other property.

The corporation shall have the power to issue and sell preferred stock in any amount not to exceed $12,500,000, of a par value of $100 per share, such stock to be entitled to 5 per cent dividends. All such stock shall be subscribed by the United States of America, and such subscription shall be subject to the call upon vote of the board of directors of the corporation with the approval of the Secretary of War at such time or times as may be deemed advisable, and there is hereby appropriated, out of any money in the Treasury not otherwise appropriated, the sum of $12,500,000, or so much thereof as may be necessary, for the purpose of making payment upon such subscription when and as called.

Receipts or certificates for payment by the United States of America for or on account of such stock shall be issued by the corporation to the Secretary of War and shall be evidence of the stock ownership by the United States. The Secretary of War is authorized to use any funds now available for the completion of the construction and equipment of such United States nitrate plants numbered 1 and 2, and accessories, either after or before the conveyance and delivery of such properties to the corporation in accordance with the terms of this act.

Distribution of Earnings.

All net earnings of the corporation not required for its organization, operation, and development shall be used—

(a) To pay dividends on outstanding preferred stock, such dividends to be paid into the Treasury of the United States as miscellaneous receipts.

(b) To develop and improve its plants and equipment.

(c) To create a reserve or surplus fund until such fund amounts to $2,500,000.

(d) The remainder to be paid into the Treasury of the United States as miscellaneous receipts.

Miscellaneous.

The Federal reserve banks shall be authorized to receive deposits of the corporation. The corporation shall not have power to mortgage or pledge its assets or to issue bonds secured by any of its properties.

The United States shall not be liable beyond its stock subscription for any debts, obligations, or other liabilities of the corporation.

The corporation and all its assets shall be deemed and held to be instrumentalities of the United States, and as such they and the income derived therefrom shall be exempt from Federal, State, and local taxation.

The directors, officers, attorneys, experts, assistants, clerks, agents, and other employees of the corporation shall not be officers or employees of the United States, within the meaning of any statutes of the United States, and the property and moneys belonging to said corporation, acquired from the United States, or from others, shall not be deemed to be the property and moneys of the United States,

within the meaning of any statutes of the United States.

The accounts of the corporation shall be audited under the regulations to be prescribed by the Secretary of War, who shall include in his annual report to Congress a detailed statement of the fiscal operations of said corporation.

The Secretary of War may appoint any officer of the War Department or any other person as a director of the corporation, and under regulations to be prescribed by the Secretary of War any officer of the War Department may serve as an officer or employee of the corporation and may receive such compensation for services rendered to the corporation as the board of directors, with the approval of the Secretary of War, may prescribe.

If any clause, sentence, paragraph, or part of this act shall for any reason be adjudged by any court of competent jurisdiction to be invalid, such judgment shall be confined in its operation to the clause, sentence, paragraph, or part thereof directly involved in the controversy in which such judgment shall have been rendered.

SECTION 2. That the right to amend, after, or repeal this act is hereby expressly reserved.

During the last session of Congress the Wadsworth-Kahn Bill was reported out by the Senate Committee on Agriculture with the following amendment:

Strike out the sentence which reads:

"And there is hereby appropriated the sum of $12,500,000, or so much thereof as may be necessary, for the purpose of making payment upon such subscription when called;" and substitute therefor the following:

In order to pay such subscription as and when called the Secretary of War is hereby authorized to sell so much as may be necessary of the supply of nitrate of soda, owned by the United States and held as a reserve by the War Department, at such prices and under such regulations as may be prescribed by the Secretary of War. All sums realized from such sale are hereby appropriated to the use of the Secretary of War for the purchase of the preferred stock of the corporation.

The construction work at No. 2 Nitrate Plant, Muscle Shoals, Alabama, which is being carried on in order to make this an effective military establishment and which work was commenced in June, is now about 50 per cent complete. The modification of limestone and coal unloading and handling equipment is progressing very rapidly. Ash handling equipments for the large power plant and for the smaller process steam plant are about 50 per cent complete, although work will be entirely finished in a very short time as the receipt of machinery is all that delays completion.

The other work at Muscle Shoals consists in modification of existing roads and construction of a small amount of new road and improvement of the storm water drainage and certain mechanical changes. These projects are about 25 per cent complete.

The work at Waco Quarry is now about 15 per cent complete.

Authority has been obtained and arrangements made to procure four of the sulphuric acid units from the Old Hickory Plant to be shipped to Muscle Shoals. These four units will have a combined capacity of from 240 to 260 tons of 100 per cent sulphuric acid per day. This will make No. 2 Nitrate Plant entirely independent as a producer of nitric acid and mixed acids in case of military emergency, as the plant is now capable of producing nitric acid as well as ammonium nitrate, and the capacity for the production of concentrated sulphuric acid will permit of the concentration of nitric acid or the manufacture of mixed acids. It is expected that a contract will shortly be made for the dismantling of the above four units at Old Hickory and their shipment to Muscle Shoals.

The designs for an ammonium sulphate plant to be constructed in conjunction with No. 2 Nitrate Plant in case the latter becomes a producer of fertilizer material are now complete. The work on this plant has been brought to a point where the final erection drawings can be prepared or the work can be turned over to a general contractor whenever authorization is given to proceed with the conversion of No. 2 Nitrate Plant into a producer of fertilizer material.

The test operation of the 60,000 k. w. steam turbine during the month showed that the turbine proved to be satisfactory when run as a three element compound unit and as a two element compound unit comprising a high pressure and a low pressure element. The maximum load carried was 33,000 k. w., this being the limit of the capacity of the transmission line over which surplus power was delivered to the Alabama Power Company. Test operation of the low pressure units with live steam was in progress at the end of the month.

Arrangements are being made to obtain special freight rates on raw materials for the Nitrate Plants.

Fixed Nitrogen Research Laboratory.

The work on the formation of ozone in the electric discharge is being continued as well as further study on the oxides of nitrogen.

In connection with the peace-time operation of the Government Nitrate Plants researches are being conducted on methods of utilizing the principal products, cyanamid, ammonia and ammonium nitrate.

Preparation of ammonia catalysts in progressing satisfactorily. Tests made at thirty atmospheres pressure to determine the ability of the catalyst to withstand water and carbon monoxide have been especially encouraging. Experiments, which are expected to provide a basis for a theory of ammonia catalysts, are still in progress. Work on gas purification is underway. Methods for estimating water vapor and oxygen are being developed.

During the past month several of the catalysts recently developed have been tested under varying conditions and have given most satisfactory results. Plans are being considered for testing the catalyst against such poisons as would be encountered under commercial conditions. Tests have also been made on the selective absorption of ammonia by such solids as aluminagel and ultra-clay and the results show a relatively high absorption by both of these materials.

Automatic Pistols to Shoot Blank Ammunition. For the purpose of training horses in becoming used to the discharge of firearms, an automatic pistol for shooting blank cartridges has been found desirable. Springfield Armory has undertaken the development of a suitable attachment for the service automatic pistol to enable it to function with blank cartridges. Preliminary tests indicate that the device will be satisfactory.

Telescopic Sight Mounts for U. S. Rifle. An improved type of telescopic sight bracket, which can be applied in a few seconds to any service rifle without altering the rifle, has been manufactured at Springfield Armory and sent to Camp Benning for test. If this device is successful it will obviate the necessity of manufacturing a special sniper's rifle.

AMMUNITION DIVISION

An order has been placed with Watertown Arsenal for the manufacture of 400 14-inch A. P. projectiles and $260,000 has been allotted for this purpose. These projectiles are to be tested for acceptance at an angle of 20 and 25 degrees.

An order has been placed with Picatinny Arsenal for the manufacture of 100 Infantry training bombs. Fifty of these bombs are to be loaded with amatol and 50 with T. N. T. These bombs are desired by the Infantry to stimulate the burst of a 75-mm. projectile.

Three sketches showing delay elements for impact grenades have been approved by the Technical Staff. Experimental work is to be undertaken by Picatinny Arsenal and Frankford Arsenal.

Bids have been requested from various watch manufacturers for development and experimental work on mechanical time fuses.

Frankford Arsenal has been requested to manufacture five fuses known as the E-6. These fuses are base detonating for use in the 2.24-inch Tank gun shell. It is desired to submit these fuses to complete jolting, jumbling, and centrifugal arming tests in order to ascertain the value of the safety features of the fuse. Frankford Arsenal has also been requested to continue study of designs of fuzes for the 2.24-inch A. P. shell.

Picatinny Arsenal has reported that they will start work immediately on .30-caliber powders containing powdered tin, lead and zinc as de-coppering ingredients. Arrangements have been made between Picatinny and Frankford Arsenals for the latter to furnish Picatinny Arsenal with necessary data for proceeding with the work on .50-caliber ammunition and other small arms powders.

A problem has been initiated at Picatinny Arsenal to investigate deterioration which may have set in in the case of shells loaded during the war. Fifty each of two lots of ammunition, which show deterioration, have been forwarded to Picatinny Arsenal for examination. These shell show shrinkage of the charge and corrosion of the boosters.

The entire quantity of pyro cotton at Raritan Arsenal has been inspected and found in excellent condition with the exception of a few broken boxes, but no broken inner linings. The entire quantity was wet down and restacked in small piles instead of the one large pile in which it was formerly stored.

The sale of Ordnance stocks of nitrate of soda to users and dealers of nitrate within the United States ended September 30th. According to the letters received from the selling agents, the total sales amount to less than 100 tons. Under the terms of the contract this material will be replaced by the selling agents before June 1, 1921, eighty dollars ($80.00) per ton of each ton sold having been allotted to re-purchase.

Reports on the development of flashless non-hygroscopic propellant powder have been received from Picatinny Arsenal. A number of successful flash reducing substances have been found for use with the 75-mm. powder, and effort is now being made to lessen the hygroscopicity.

Change has been made in the design of the 4.7-inch common steel shell, Westervelt Board Project, in order that they may be made from 4.7-inch shell forgings now on hand. These changes were slight, involving only a small increase in the interior cavity.

Arrangements are being made with the Washington Steel and Ordnance Company and the Bethlehem Steel Company to test inert armor piercing projectile fuzes in the experimental and ballistic samples of armor piercing projectiles submitted by them for plate tests.

Frankford Arsenal has been directed to continue development of the various types super-sensitive fuzes for the 37-mm. gun caliber shell. Twenty-five Mark XIX point detonating fuzes, known experimentally as No. 2-A type, have been forwarded to the Proving Ground for firing tests.

Arrangements have been made for flight test of the eight 14-inch Midvale armor piercing projectiles. Four of these projectiles have a patented ring on the base which materially decreases the deformation at plate impact.

Drawing of the 12-inch armor piercing projectile submitted by the Washington Steel and Ordnance Company, has been approved.

Development program for 37-mm. ammunition has been drawn up and submitted to the Technical Staff for approval. This program includes all the types desired by the Tank Corps, Air Service and the Infantry.

A 37-mm. Baldwin anti-aircraft gun, shipped from Springfield Armory, is now being installed at Picatinny Arsenal to be used in the development of a satisfactory shell and propellant. The DuPont and Hercules Powder Companies have each submitted samples of powder for test and Picatinny Arsenal is manufacturing experimental samples.

Major Miles of Picatinny Arsenal and Major Hunter of the Ordnance Office, recently visited Massachusetts Institute of Technology, Clark University, Worchester, Massachusetts, Yale University, in connection with the experimental development work being carried on at these institutions for the Ordnance Department.

Lieut. Paul L. Deylitz, of the Ammunition Division, has been detailed to Watertown Arsenal to take up a course at the Massachusetts Institute of Technology.

The Atlas Powder Company is co-operating with this office in the preparation of a suitable hand grenade powder. Fifty Mark II defensive hand grenades have been sent out to the Reynolds Experimental Laboratory in order that the Atlas Company may load these with their compositions and test the same before submitting further samples to Picatinny Arsenal.

PATENTS CONTRACTS-PERSONNEL FINANCE

ADMINISTRATION-DIVISION "SERVICE"

SUPPLIES ADVISORY

The Board of Officers appointed for the purpose of revising previously existing orders concerning the organization of the Ordnance Office has completed its work and submitted report, in compliance with which Office Order No. 164, dated November 20, 1920, has been issued.

Under the new organization the Office of the Chief of Ordnance is divided into a General Office, the Technical Staff, the Manufacturing Service, the Field Service, the Nitrate Division and the Administration Division.

The General Office comprises the Executive Section, the Recruiting and Training Section and the War Planning Section. Supervision of the District Offices and the Salvage Board is assigned to the Assistant Chief of Ordnance.

The Administration Division comprises the Civilian Personnel Section, the Advisory Section, the Contract Section, the Finance Contact Section, and the Auxiliary Section.

In addition to the Technical Staff, an Ordnance Committee is provided for, whose membership shall be designated by the Chief of Ordnance, to consider and recommend action upon all matters affecting materiel designed for or intended to be issued to the service coming within the jurisdiction of the Technical Staff, and upon such other matters as may be referred to it by the Technical Staff.

The Manufacturing Service comprises all the former manufacturing divisions and, in addition, an Arsenal Orders Branch; and an Arsenal Administration Section, for the purpose of establishing general rules and regulations for the conduct of business at Ordnance establishments and to handle all questions arising between such establishments and other branches of the War Department, or other governmental departments. Also to handle all questions concerning hours of labor, leave, determination of rates of pay, etc.

No material changes have been made in the organization of the Field Service and the Nitrate Division.

War Department, Office of the Chief of Ordnance, Washington
November 20, 1920.

ORGANIZATION OF THE ORDNANCE OFFICE.

SECTION I.

1. Office Order No. 495, dated January 7, 1919, and all Ordnance Office Orders affecting the organization of the Ordnance Office conflicting with the following provisions are hereby revoked.

2. It is the function of the Ordnance Department to design, procure, produce, inspect, store, preserve, distribute and maintain such matériel as shall be prescribed by the Secretary of War.

3. The office of the Chief of Ordnance shall be divided into the following groups:

General Office, Technical Staff, Manufacturing Service, Field Service, Nitrate Division, Administration Division.

The Chiefs of the several sections of the General Office and of each of the other groups named shall report directly to the Chief of Ordnance. Charts and detailed group orders showing the organization and methods by which they will operate shall be prepared by each group and shall have, when approved by the Chief of Ordnance, the same force and effect as this order. They shall maintain the records, rosters, and all other data required by their functions and shall submit to the Chief of Ordnance such special reports, digests, etc., as he may direct. They shall furnish reports and information of their own operations to other groups of the Ordnance Office and to other official agencies at the latters' request, subject to the approval of the Chief of Ordnance. Each group or division shall establish and control such liaison as pertains exclusively to its functions. Other liaison shall be under the direct control of the proper section of the General Office.

SECTION II.

4. The General Office shall consist of the Executive Section, the Recruiting and Training Section, and the War Planning Section. The Assistant Chief of Ordnance shall supervise the District Offices and the Salvage Board.

5. It shall be the duty of the General Office:

a. To supervise the organization, administration and operation of the Ordnance Office and to perform such other duties as the Chief of Ordnance may direct. (Executive Section.)

b. To supervise and co-ordinate the liaison established by the Ordnance Office with other agencies of the War Department and the Federal Government. (Executive Section.)

c. To receive and distribute such correspondence as the Chief of Ordnance may direct. (Executive Section.)

d. To receive the annual estimates prepared by the groups covering their respective functions, and to submit them to the Chief of Ordnance for such action as he may direct. (Executive Section.)

e. To supervise the preparation and publication of official literature and other news matters concerning the Ordnance Department. (Executive Section.)

f. To recruit, train, and maintain the records of assignment of the military personnel, and to control and operate the military educational facilities. (Recruiting and Training Section.)

g. To exercise general supervision and co-ordination over the preparation of the war plans of the Ordnance Department, including reports and statistics of requirements and progress under those plans. (War Planning Section.)

6. It shall be the duty of the Salvage Board to take charge of the disposition of all manufactured materials, equipment, and buildings which are or may become the property of the United States as the result of the termination of contracts made by the Ordnance Department. In its actions it shall be guided by such order and regulations promulgated by the Chief of the Supply Division, General Staff, as may be applicable to its work and such instructions as it may receive from the Chief of Ordnance from time to time.

SECTION III.

7. It shall be the duty of the Administration Division:

a. To maintain the records of employment, discharge and service of the civilian employees of the Ordnance Department. (Civilian Personnel Section.)

b. To establish and maintain uniform procedure in the work of all personnel branches of the various groups of the Ordnance Office. (Civilian Personnel Section.)

c. To administer the Civil Service Regulations. (Civilian Personnel Section.)

d. To handle all relations with the Appointment Division of the War Department, and the United States Civil Service Commission. (Civilian Personnel Section.)

e. To assist in obtaining legal advice on all matters affecting the Ordnance Department. (Advisory Section.)

f. To act as liaison with the Attorney General, the Judge Advocate General, the Comptroller of the Treasury, and the Auditor for the War Department with respect to the opinions and decisions of these officers. (Advisory Section.)

g. To conduct for the Ordnance Department all matters relating to general legislation and actions upon compulsory orders, requisitions or condemnation of private property. (Advisory Section.)

h. To prepare and prescribe the general forms of contracts to be used by the Ordnance Department, and to record and supervise the distribution of all contracts made by Ordnance contracting officers. (Contract Section.)

i. To publish all orders, bulletins, circulars, etc., and to arrange for

the printing and issue of all Ordnance publications and miscellaneous printed matter except drawings.

j. To compile historical data.

k. To be responsible for the office service, including office space, communications, supplies, equipment, and maintenance.

l. To control and operate the Ordnance Post Office and the mail and record system for the whole office.

m. To act as liaison on finance matters with the Chief of Finance, all Bureaus of the War Department, and other Government agencies, and to maintain record of the status of appropriations and apportionment of funds to the groups of the Ordnance Office. (Finance Contact Section.)

n. To audit Reservation of Funds and Allotment Requests; to advise on questions pertaining to financial operations; and to verify code classifications. (Finance Contact Section.)

SECTION IV.

8. It shall be the duty of the Technical Staff:

a. To keep informed of the trend and progress of ordnance development at home and abroad.

b. To rerommend to the Chief of Ordnance new and experimental types of ordnance which, when approved by the Chief of Ordnance, will be developed and designed by the Chief of the Manufacturing Service.

c. To approve for the Chief of Ordnance design and manufacturing specifications and drawings and studies covering types and experimental matériel, and to approve texts of revision of all matériel, in which the functioning will be affected.

d. To have charge of and administer all proving grounds operated as such by the Ordnance Department.

e. To conduct or approve programs of, all trials of pilot Ordnance Matériel except shop tests, firing tests at arsenals, and preliminary road tests; and wherever possible to attend important trials of ordnance in other services in this country and abroad.

f. To develop plans for wider publication and distribution of ordnance engineering data, and to encourage discussion and developments of its theoretical principles.

g. To maintain and administer the technical library of the Ordnance Office.

h. To confer, as the representative of the Chief of Ordnance, with the Line and General Staff of the Army regarding types of ordnance desired to be developed.

i. To arrange for the assignment to the Technical Staff of qualified officers of the Line of the Army and such civilian engineers as found advisable.

j. To conduct research work in ballistics and metallurgy, and to prepare general metallurgical specifications.

k. To approve all programs for experimental and research work initiated for the purpose of improving ordnance matériel.

9. The Ordnance Committee is advisory to the Chief of the Technical Staff. Its membership shall be designated by the Chief of Ordnance. It shall be the duty of the Ordnance Committee to consider and recommend action upon matters affecting matériel designed for or intended to be issued to the Service coming within the jurisdiction of the Technical Staff, and upon such other matters as may be referred to it by the Chief of the Technical Staff.

SECTION V.

10. It shall be the duty of the Manufacturing Service:

a. To design, develop, procure, produce and inspect all ordnance matériel, ammunition, pyrotechnics, gauges and other ordnance and ordnance stores, and to perform all duties incident thereto not otherwise specifically assigned by the Chief of Ordnance.

b. To prepare basic data sheets and requirements schedules in accordance with the approved projects of the War Department, and to set up the detailed schedules and initiate the work thereunder to meet the requirements.

c. To prepare estimates of the cost of all manufacturing and experimental programs and price lists.

d. To sumbit for the approval of the Technical Staff design and manufacturing specifications and drawings and studies covering type and experimental matériel; to submit to the Technical Staff for approval texts of revision of all matériel in which functioning will be affected; and to approve all drawings and specifications not requiring action by the Technical Staff.

e. To carry out, in conjunction with the Field Service, all projects for the alteration of ordnance matériel.

f. To initiate, conduct and follow-up experimental and development work required for the development of new types or the improvement of existing types.

g. To establish and maintain Ordnance standard practice sheets covering the standards to be used in Ordnance design.

h. To maintain full information with respect to available sources of supply for all material, incuding raw material, and with respect to the manufacturing facilities in the United States capable of producing Ordnance material.

i. To assist manufacturers to become acquainted with ordnance matériel and manufacturing problems connected therewith.

j. To have charge of the making of blue prints, brown prints, photostats, etc., including all apparatus pertaining thereto.

k. To handle all Interbureau Procurement Instructions.

l. To provide for the storage and distribution of experimental matériel.

m. To be responsible for the subject-matter for specifications and for handbooks and pamphlets covering descriptions and instructions for the use of matériel.

n. To obtain work from other federal departments for the arsenals suited to their needs and facilities, when necessary to provide continuous employment for the nucleus of their organizations. (Arsenal Orders Branch.)

o. To establish general rules and regulations for the conduct of business at Ordnance establishments and to handle all questions arising between such estabishments and other branches of the War Department or other governmental departments. (Arsenal Administration Section.)

p. To handle all questions concerning hours of labor, leave, determination of rates of pay, housing, transportation, and general conditions affecting the safety and welfare of employees. (Arsenal Administration Section.)

Q. To compile and furnish all Ordnance statistical data, to follow up, compile and report on progress of Ordnance activities.

SECTION VI.

11. It shall be the duty of the Field Service:

a. To supply all ordnance material to troops; to repair and maintain material in the hands of troops, and to control and operate the personnel, organizations, permanent establishments and field facilities assigned to these duties.

b. To receive and act upon all requisitions for standard articles of ordnance matériel.

c. To maintain stocks in conformity with Requirements Schedules furnished by the Chief of Manufacture, establishing proper maximum and minimum limits for safety of reserve and issue in accordance with approved policies.

d. To handle all condemnations, sales or other authorized dispositions of Ordnance and Ordnance stores except those of components to be used in manufacturing.

e. To co-operate with the Office of the Chief of the Manufacturing Service and the using Service in the uniform packing and marking of Ordnance stores.

f. To store all ordnance material procured for issue; to store component material when requested by the Chief of Manufacture and to arrange for the shipments incident thereto.

g. To control and operate all Ordnance Establishments used exclusively for storage and maintenance purposes.

h. To maintain a running inventory of all Ordnance stores, including component stores for which it is responsible.

i. To inspect, maintain, alter and repair all ordnance matériel in the hands of troops and in storage; and to perform this work under the technical supervision of the Manufacturing Service which shall direct alterations after consultation with the Field Service.

SECTION VII.

12. It shall be the duty of the Nitrate Division to take charge of all matters concerning the fixed nitrogen interests of the Ordnance Department and the operation and future disposition of fixed nitrogen plants.

SECTION VIII.

13. Each group shall control and operate the establishments hereunder assigned to it by this Section, except as otherwise provided in this Order. The assignment of Ordnance Establishments shall be as follows:

Technical Staff—Aberdeen Proving Ground.

Manufacturing Service—Frankford Arsenal, Watertown Arsenal, Picatinny Arsenal, Watervliet Arsenal, Rock Island Arsenal, Chicago Storage Depot, Erie Howitzer Plant, Rochester Arms Plant, Springfield Armory, Rochester Gun Plant.

Field Service—Augusta Arsenal, Benicia Arsenal, Hawaii Ordnance Depot, Aberdeen Supply Depot, Amatol Arsenal, Erie Proving Ground, Middletown General Ord. Depot, Charleston General Ord. Depot, Curtis Bay General Ord. Depot, Morgan General Ord. Depot, Penniman General Ord. Depot, Old Hickory Powder Plant, Manila Ordnance Depot, Panama Ordnance Depot, San Antonio Arsenal, Delaware General Ord. Depot, Neville Island Supply Depot, Savanna Proving Ground, Pig Point General Ord. Depot, Raritan Arsenal, Seven Pines General Ord. Depot, Sparta General Ord. Depot, Tullytown Arsenal, Wingate General Ord. Depot, Woodbury General Ord. Depot.

Nitrate Division—U. S. Nitrate Plant No. 1, U. S. Nitrate Plant No. 2.

ORDNANCE LITERATURE

Book Reviews

LUCK ON THE WING.—Ever since the success of Empey's "Over the Top," members of the A. E. F. have been writing of their personal adventures overseas, and sometimes the American public has wished that the would-be authors had stayed on this side and spared them the flood of tiresome reminiscences, which often ensued.

"Luck on the Wing," however, by Major Elmer Haslett, Air Service, U. S. A., is decidedly not to be classed with this type of war-literature.

In simple but vivid language, touched with an unique humor, Major Haslett tells of his adventures as an observation officer, from the day at Fort Sill when he signed up for that work, scarcely knowing what he was "in for"—except that it meant getting to France almost at once—to the day when he was released from a German prison after months of futile attempts to escape.

The best summary of this interesting book, perhaps, is contained in part of the introduction by General William Mitchell (Commander-in-Chief of the American Air Forces at the Front):

"'Luck on the Wing' has two distinct sources of value: First, it presents a clear graphic picture of the life led by our fighting airmen during the three great actions in which American soldiers played so important a part—Chateau-Thierry, St. Mihiel and the Argonne—and best of all the picture is a truthful one; and second it, all the more forcibly because often quite unconsciously, brings out clearly the lack of understanding of the functions of the Air Service, a lack which in the final analysis was responsible for the greater part of whatever of dissatisfaction and disappointment with this branch of the Military Service there existed in the American Expeditionary Forces in France."

Published by E. P. Dutton & Company.

THE AMERICAN ENGINEERS IN FRANCE.—The consistent and farseeing effort and the steady heroism that characterized the work back of the lines of the A. E. F., which was so essential to success at the front, is nowhere so interestingly portrayed as in "The American Engineers in France," by William Barclay Parsons, late Colonel, 11th U. S. Engineers.

Colonel Parsons, while modestly disclaiming the writing of a detailed account of the work done in France by American engineers, has in reality produced a very creditable history of their efforts, for his book presents both a comprehensive and an interesting account of the organization of the Engineer Corps and also of its varied activities overseas. He describes with picturesque touch the details of the vast construction problems involved in building the ports, cantonments, depots, roads and bridges. Concerning the railway operations he writes of the French railways, the American railway operations, the storage yards, and the American locomotives and cars.

"The American Engineers in France" is more than a description of the work of the Engineer Corps, however, as it describes all types of engineering activities and there are given many interesting sidelights on the use of Ordnance matériel. Some of these subjects are artillery, ammunition, tanks, tractors, and railway mounts. The engineering involved in their transportation, camouflage, and utilization is vividly described; and the developments resulting from active operations gives one a better idea of the complexity of the problems involved in the design and manufacture of Ordnance to meet field conditions.

The chapter concerning the water supply problem is replete with interest, especially as it describes some instructive phases of the national psychology of the English and French. The French used local resources or set up water supply points in great numbers, individually of small capacity and of the simplest character. The British was the converse practice, digging or boring wells of generous flow furnished with rather complex equipment. This difference of construction rose largely from opposing traits of national character, he states, and adds that it characterized the entire work of the two nations. "One nation by nature leans to lightness, delicacy, and mobility, the other to strength, solidity, and permanence."

Because of the fact that the work of the Engineer Corps in the battle area constitutes the foundation of much of the manoeuvering and of the offensive and defensive tactics of the troops, a knowledge of their work is basically required for a distinct comprehension of the war problem; hence a reading of Colonel Parsons' book is a fitting introduction to a study of the more tactical aspects of the war with Germany.

Published by D. Appleton & Co.

THE TANK CORPS.—It might well be said that the authors of "The Tank Corps," Major Clough Williams-Ellis, M. C., and A. Williams-Ellis, have presented in their masterly narrative of the British tanks a striking commentary on the need for preparedness. Victory, they say, lies not in superior man power but in superior weapons. This lesson is driven home from the first interesting chapters narrating the birth of this mobile weapon of offense, founded largely on an American invention, and detailing its development through a maze of experiments and difficulties, then with vivid touches describing them ludicrously lumbering into actions where they constituted the extra margin of fighting power destined to wreck the Huns—according to Marshal Foch—to the prophetic glimpse of wars to come, fought by the armored cruisers of the sea, air and land.

"We know too well the tragic cost of one day of war, and it has been said that had we been visibly prepared the Germans would not have attacked," emphasizing the need for ample matériel preparations in advance of hostilities so as to avoid even the threatening of war.

The forté of the tank is well summed up in this phrase: "Tanks of various speeds and carrying various weapons, will replace both infantry and cavalry, for one full-size modern heavy tank, holding eight men, has the aggressive power of a hundred infantry with rifles, bayonets, bombs and Lewis guns."

Ample credit is given to the skill and courage of both the French and American tank corps, and as praise from those without our gates is doubly sweet, the words of Maj. Gen. H. J. Elles, commanding the British Tank Corps in the field, to the 301st Battalion on the eve of their departure for America, are not without interest: "In the field the 301st Battalion, after experiencing heavy casualties in its first engagement at Bony, which might have deterred less determined troops, volunteered for the next action, in which, as in subsequent ones, it inflicted heavy casualties upon the enemy at Brancourt, the Selle and Catillon. I feel I am voicing the opinion of all commanders and troops who have been associated with them, in expressing sincere regret at the departure of our American comrades and in wishing them all good fortune in the future."

The book is well written, with vivid descriptive power, lightened by frequent humorous passages and as a well-rounded narrative of the history both in genesis and in action of this steel-clad pachyderm—and for its augury as to its future prowess—it is well worth the study of the Ordnance enthusiast.

Published by George H. Doran Company.

MILITARY EXPLOSIVES.—A book which will undoubtedly prove of great interest to officers of the Reserve Corps who have a lack of knowledge of the technicalities of the manufacture, appearance, and characteristics of ammunition used in warfare is "Military Explosives." This publication has been prepared by the Ammunition Division, Ordnance Department, U.S.A., for use of the Department in the instruction of student officers. A large portion of the original manuscript was prepared by Capt. John A. Marshall, but it has been considerably enlarged and revised by Lieut. Col. C. G. Storm. There also collaborated in the preparation of the text Maj. J. Herbert Hunter, Capt. C. A. Tibbals, Jr., and Lieut. J. E. Wood.

While the book is necessarily prepared for use as a text book and so is considerably condensed and therefore restricted in its range of subjects, it is so well written that it serves as very fitting introduction for the neophyte in the study of ammunition. Much benefit may be derived from its reading by those who have a knowledge of explosives as a means of bringing that knowledge up-to-date concerning the more recent advances made during the war and the newest methods of manufacture.

The introduction to the book defines various types of explosives, the balance is divided into two parts: Propellants, and Military High Explosives. The book is well illustrated, containing pictures of the different apparatus used in the manufacture of explosives as installed in plants in operation during the war. There are also a number of diagrams explanatory of the text.

The chapter devoted to trinotrotoluene (T.N.T.) is typical of the arrangement of the subject matter. There is given a general description of the explosive, then its properties, manufacture, purification, use, inspection, and storage are described in detail. Its description may be of interest. "T.N.T. usually resembles in appearance powdered maple or brown sugar, although in different grades of refinement or purity its color and appearance vary. When pure it is a crystalline powder of light yellow color. It dissolves readily in ether, acetone, alcohol, and various other solvents, but it is practically insoluble in water. The importance of this explosive is based, first, upon its relative safety

in manufacture, loading, transportation, and storage; second, on the fact that it is not hygroscopic; third, on the lack of any tendency to form unstabled compounds with metals, and finally upon its powerful, brisant, explosive properties."

Published by the Superintendent of Documents, Government Printing Office.

THE LEAGUE OF NATIONS AT WORK.—What appears to be an unbiased attempt to present to American readers the birth, development, purpose and present status of the conference now in session at Geneva is presented in "The League of Nations at Work" by Arthur Sweetser. The author was a member of the American Peace Commission and the Provisional Secretariat of the League of Nations, and so had access to facts which he says "throw an entirely different interpretation upon the League than that almost universally held."

He states, "I am convinced that almost no one, either friend or foe, understands what the league actually is. Its friends are tempted to exaggerate it as a panacea for all world ills; its enemies to misrepresent it as a superstate. It is in fact neither, but on the contrary a new link in the chain of human relationships made imperatively necessary by the annihilation of distance as a barrier between states."

From the point of view of the purpose of the book, the subject matter is well arranged. There is first presented the background of the war as a basis for the need of the organization. The skeleton of the League is then outlined briefly describing the different sections. The chapter on the status of the League in 1914 presents some interesting surmises of what might have been the outcome had the League been in operation at that time and the author says: "Sir Edward Grey's statement, that if the League machinery had been available the World War would not have taken place, is almost staggering in its boldness."

Some of the other subjects treated are the Permanent Court, The Secretariat, Disarmament, Minorities, Mandates, Freedom of Transit, Economic Co-operation, Open Diplomacy, and the League as Mediator.

For one desiring a fresh and interesting viewpoint on the actual workings of the League, which is now so paramount in the public eye, the book is well worth a most careful perusal.

Published by The Macmillan Company.

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